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FARM MACHINERY AND EQUIPMENT

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FARM MACHINERY AND EQUIPMENT

BY

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FARM MACHINERY AND EQUIPMENT

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PREFACE TO THE THIRD EDITION

Many developments have occurred in the field of farm machinery in the 10-year interval between the second and third editions of this book. Improvements in tractor implements, especially attachments for row-crop tractors, the perfection of the self-propelled combine, the one-man self-tying hay baler, the cotton harvester, the corn picker, and the beet harvester have brought about changes in farming practices that have been largely instrumental in reducing labor requirements and production costs.

The rapid progress in the mechanization of agriculture has made it necessary in the preparation of this edition to revise and rewrite the greater portion of the text. Much obsolete material has been discarded and replaced with new subject matter. New chapters, discussing new machine developments, have been added, and some chapters have been consolidated to facilitate description of types of equipment. Many of the illustrations have been replaced by either new or improved ones to show the latest types of machines now available.

In general, an effort has been made to bring the entire subject matter of the text up to date and to show the many postwar developments in the field of farm machinery.

The author is indebted to the farm implement manufacturers for their splendid cooperation in furnishing descriptive literature and illustrations. He especially desires to express his appreciation to Prof. Fred R. Jones for his helpful suggestions and criticisms. A sincere attempt has been made to give credit wherever due, and any oversight is not intentional.

HARRIS PEARSON SMITH

COLLEGE STATION, TEX.
January, 1948

PREFACE TO THE FIRST EDITION

This book is intended primarily as a text for use in farm machinery classes for agricultural and agricultural engineering students. It is also intended as an aid to farm equipment salesmen and dealers, agricultural extension workers, farmers, and others interested in the introduction and use of laborsaving equipment for the farm.

It has been the aim of the author to present a treatise on farm machinery covering the most important types of machines used in general farming. The book opens with a discussion of the more important phases of physics which are of assistance in analyzing the design, operation, and adjustment of the machines taken up in later chapters. Following this is a brief description of the various elements of a farm machine, together with typical applications. An innovation is the chapter on the selection of farm machinery in which are given suggestions as to the best place to purchase the equipment.

The main part of the book is a discussion of the various types of farm machines, their design, construction, operation, and efficiency. More space is given to plows than ordinarily because of their importance in preparation of the seedbed for all crops. Machinery used in growing, harvesting, and preparation of cotton for the market is given special attention. The combined harvester-thresher is thoroughly covered. The author has endeavored to arrange the discussion of these machines in the logical sequence in which they are usually applied to farm work.

The entire field of farm machinery as applicable to this country has been covered as fully as space will permit.

An effort has been made to cover the latest types of machines developed for the farm, those machines that have proved to be economical in their use and instrumental in reducing the cost of production.

The author is indebted to Dr. O. W. Silvey, of the Physics Department, and Professor E. R. Alexander, of the Department of Agricultural Education, of the Agricultural and Mechanical College of Texas. Thanks are also due Daisy Brogdon for assistance in preparing the manuscript.

HARRIS PEARSON SMITH

COLLEGE STATION, TEX.
May, 1929

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CHAPTER I

FARM MACHINERY AND ITS RELATION TO AGRICULTURE

In the beginning all crops for the sustenance of mankind were produced and prepared by human muscles. Many centuries passed before the power of animal muscles was used to relieve those of the human being. With the discovery of iron, tools were fashioned that further relieved the labor of human muscles. The transition from subsistence farming to this modern power-farming age was at first slow, but with the development of the steel plow, the internal-combustion engine, and other modern farm machines, the movement has accelerated beyond the wildest dreams of our forefathers. The changes brought about during the past decade have so tremendously affected human values that one wonders what effect farm machines of the future will have on our welfare.

1. Machinery Reduces Hours of Labor.—The effect of the mechanization of agriculture is shown in the number of man-hours required to grow and harvest an acre of wheat yielding 20 bushels. In 1830, when the grain was sown by hand and harvested by hand with a cradle, 55.7 man-hours were required. In 1896 with the use of a horse-drawn drill and binder, 8.8 man-hours were required, while in 1930 with the tractor-drawn drill and combine, only 3.3 man-hours were necessary.[1] Similar reductions in man-hour requirements have been made in the production of most field crops. Cotton, as a whole, requires more man-hours in its production than any other of the major crops grown. The average number of man-hours required in 1943 to grow 1 acre of cotton in the High Plains region of Texas was 10.45 with one-row horse-drawn equipment, 6.6 man-hours with two-row horse-drawn equipment, 5.5 man-hours with two-row tractor outfits, and 4.3 man-hours with four-row tractor machines. An average of 14.2 man-hours per acre is required to hand-snap an acre of cotton.[2] With two-row tractor equipment 2.6 hours of tractor work were required per acre, but with four-row equipment

[1] *U. S. Dept. Agr. Misc. Rept.* 157, p. 2, 1933.

[2] *Tex. Agr. Expt. Sta. Bull.* 652, p. 16, 1944.

only 1.4 hours of tractor work were required per acre previous to harvest. Farmers in central Iowa usually expend from 6 to 12 man-hours of labor per acre in preparing seedbeds, planting, and cultivating corn. With certain combinations of equipment and methods at Iowa State College, however, the requirements were only from 3 to 5 man-hours per acre.

2. Good Equipment Reduces Production Costs.—Much has been accomplished through the use of modern farm machines in reducing the cost of producing farm crops. It is not hard to visualize the difference in the cost of producing an acre of wheat in 1830 as compared to that of 1946. Studies made in the High Plains region of Texas on the production of cotton show the influence of types of farm machines on production costs.[1] In 1943, when the average yield was 180 pounds per acre, to grow and hand harvest a pound of cotton cost 8.4 cents with two-row, and 7.8 cents with four-row tractor equipment. When the cotton was machine-harvested the cost was reduced to 4.5 cents for the two-row tractor equipment and to 3.8 cents for the four-row equipment. Interest and rent are included in these costs. In areas where the annual rainfall averages 45 to 50 inches and more hoeing and cultivating are required, the cost of producing a pound of lint cotton amounts to 13 cents.

Production costs are also influenced by soil type, topography, climate, kind of crop, and the size and contour of the field.

3. Special Machines for Special Crops.—The nature of plant growth is such that only a few farm machines are adapted to more than one crop. By minor changes planters for planting row crops will sow the seeds of most field row crops. Grain drills will plant the seeds of all the small grains, but special attachments are needed for the small grass seeds. Row-crop cultivators are suitable for all crops grown in rows spaced from 36 to 42 inches apart. Broadcast binders, combines, and threshers can be adjusted to handle satisfactorily any of the broadcast crops and some of the row crops. Some of the one-crop machines are the corn picker, potato planter and digger, beet digger, and cotton harvester. Plows and harrows are indispensable in the preparation of the seedbed for all row and broadcast crops.

4. Rubber Tires on Farm Machines.—Numerous tests with tractors and other farm machines equipped with rubber tires reveal the relative advantages and disadvantages.

Advantages of rubber-tired tractors are (1) higher operating speeds, (2) less power required for the same load, (3) less fuel consumption, (4) decreased rolling resistance, (5) less vibration, (6) easier handling qualities, and (7) greater comfort for the operator.[2]

[1] *Tex. Agr. Expt. Sta. Prog. Report* 912, 1944.

[2] *Agr. Eng.* **14,** No. 2, p. 39, 1933; **16,** No. 2, p. 45, 1935; **17,** No. 2, p. 73, 1936.

Disadvantages are (1) difficulty of holding on listed ground, (2) greater slippage on wet soil, (3) greater initial cost, and (4) possibility of punctures.

When used on other farm machines, such as combines, potato planters and diggers, and sprayers, rubber tires reduce the drawbar pull, the fuel consumed by the tractor, vibration, and dust, as well as make transportation easier from field to field and along highways.

5. Machinery for Terraced Fields.—The expansion of soil and water conservation on farms has created a need for specially designed farm machines that will operate efficiently on terraced fields. Engineers studying the problems no doubt will in the near future design plows, planters, cultivators, and harvesters that will be flexible enough to operate satisfactorily on terraced and contoured lands.

6. Breeding Crops to Suit Machinery.—Certain field crops do not readily lend themselves to machine harvesting. The drooping heads of some varieties of grain sorghum make it difficult to head them without cutting excessively long stems. Plant breeders have developed varieties of sorghum with straight, erect heads of uniform height that are well adapted to combining. As cotton matures, it produces long vegetative and fruiting branches with an abundance of foliage, which make it difficult to harvest with machinery. Plant breeders, however, have recently developed types of cotton plants that are more suitable to machine harvesting.[1] Fluffy types are suitable for the picker and nonfluffy or stormproof types may be harvested by the stripper.

7. Farm Management.—Farm machines designed for higher speeds, constructed of heat-treated steels, and equipped with more durable bearings will lessen operating time and will lower costs. Terracing and contouring of fields will cause changes in farming practices, both in the types of machinery used and in cropping systems. In the past, machines were designed for large farms, but now the trend is to develop machinery for small farms. These and various other factors will materially affect the management of farm labor and equipment.

8. The Future.—Improvements in farm machinery during the past decade have been so rapid that one wonders what the future holds. Rather than forecast for the future, several questions are enumerated:

1. Will a special grade of glass be used for plow moldboards?
2. How will light, strong alloys affect the strength and weight of farm machinery?
3. Will plastics be used in the construction of farm machinery?
4. How will electronics affect the use and operation of farm equipment?
5. How will synthetic oil affect the operation of farm power equipment?

[1] *Texas Agr. Expt. Sta. Bull.* 452, p. 54, 1932; 511, p. 32, 1935; 580, 1938; and 686, p. 20, 1946.

6. Will the airplane be used extensively for the seeding of broadcast crops?

7. Will new developments in farm equipment, such as stalk shredders, be important in the control of insect pests of farm crops?

8. Will a large percentage of the farms of the country have drying equipment to aid in saving crops and in producing higher quality farm products?

9. Will flame cultivation eliminate most of the hand hoeing and weeding of row crops?

10. Numerous other questions may be cited but these are sufficient to show the possibility for improving farm machinery in the future.

PART II

PRINCIPLES OF FARM MACHINERY

CHAPTER II

MECHANICS

A clear conception of the fundamental principles of mechanics, as well as their practical application to machinery, is necessary to a comprehensive study of farm machinery.

9. Force.—Force is the action of one body upon another which tends to produce or destroy motion in the body acted upon. Force may vary in magnitude and in method of application. In general, force is associated with muscular exertion. This, however, does not completely cover the scope and work of force because an electric current, freezing of a liquid, and ignition of explosives may exert a certain amount of force. To be able to compare different forces, there must be some unit by which to compare them. Such a unit is called the *pound weight*.

10. Work.—Whenever a force is exerted to the extent that motion is produced, work is performed. Work is measured by the product of the force times the distance moved. There is a distinction between the term *work* in common use, and the term *work* used scientifically. The latter is referred to above. By this it can be seen that a man could have worked very hard and become fatigued but not have accomplished any work in a scientific sense. For example, suppose a man pushes on a door or gate all day and fails to open it; physically he has worked and is tired out, but scientifically he has not accomplished any work because he did not open the door; the force applied did not move the door any distance. The unit used in measuring work is the *foot-pound*, force being measured in pounds and distance in feet. A foot-pound of work is done when a body is moved 1 foot against a force of 1 pound weight. The amount of work required to place a 100-pound bag of grain on a wagon that has a box 4 feet from the ground can be determined by multiplying the weight, 100 pounds, by the height, 4 feet, which will equal 400 foot-pounds of work done to place the bag of grain upon the wagon.

11. Power.—Power is the rate of doing work. To determine the power used or transmitted by a machine, the force must be measured,

also the distance through which the force acts, and the length of time required for the force to act through this distance. The units of power ordinarily used in America are the *foot-pound per second*, the *foot-pound per minute*, and the *horsepower*.

If a body is moved 1 foot per second against a force of 1 pound weight, the rate of work is 1 foot-pound per second. If it moves 1 foot per minute against the same force the rate is 1 foot-pound per minute. If it moves so that 33,000 foot-pounds are done each minute, the rate is 1 horsepower. The horsepower is based on the rate that a 1,500-pound horse can do work. If such a horse pulls 150 pounds, 10 per cent of its weight, and moves at the rate of 220 feet per minute, or 2½ m.p.h., it would do 33,000 foot-pounds of work per minute, this being equal to 150 times 220, or 33,000 foot-pounds, or 1 horsepower.

12. Simple Machines.—A machine is a device that gives a mechanical advantage which facilitates the doing of work. The term is usually associated with such tools as grain binders, threshing machines, mowing machines, and so forth. But really such machines are made up of many simple machines.

There are six simple machines, namely, the lever, the wheel and axle, the pulley, the inclined plane, the screw, and the wedge. These can be reduced to three, which are the lever, the inclined plane, and the pulley. Any simple machine is capable of transmitting work done upon it to some other body. The mechanical advantage of a machine is the ratio of the force delivered by the machine to the force applied. The force which operates the machine is called the *applied* force. The efficiency of the machine is the ratio of the work accomplished by the machine to the work applied to the machine. If the efficiency of a machine could be 100 per cent, perpetual motion would exist. Since there is always a loss due to friction, the efficiency of the machine falls below 100 per cent.

13. The Lever.—The lever is a rigid bar, straight or curved, which rotates about a fixed point called the *fulcrum*. It has an applied force and a resisting force that are well defined by their names. The lever arms for a straight bar are the parts or ends on each side of the fulcrum if the forces act perpendicular to the bar. The mechanical advantage of the lever is the ratio of the length of the lever arm of the applied force to the length of the arm of the resistance force, or

$$\text{Weight} \times \text{weight arm} = \text{applied force} \times \text{force arm}.$$

Levers are of three classes (Fig. 1). In the lever of the first class the applied force is at one end, and the resisting force or force exerted by the object to be moved at the other. The fulcrum, or fixed point, is

placed between the applied and the resisting forces. Such a lever may have a mechanical advantage of any value, depending directly upon the length of the lever arm between the fulcrum and the point of applied force as compared with the length of the lever arm between the fulcrum and the point of resisting force. The majority of levers found on farm machinery will fall in this class.

Levers of the second class have the applied force at one end, the fulcrum at the other, and the resisting force between them. This class of levers will have a mechanical advantage that will always be greater than unity. As in the case of the lever of the first class, a lever of the second class sacrifices speed and distance for a gain in pull or force.

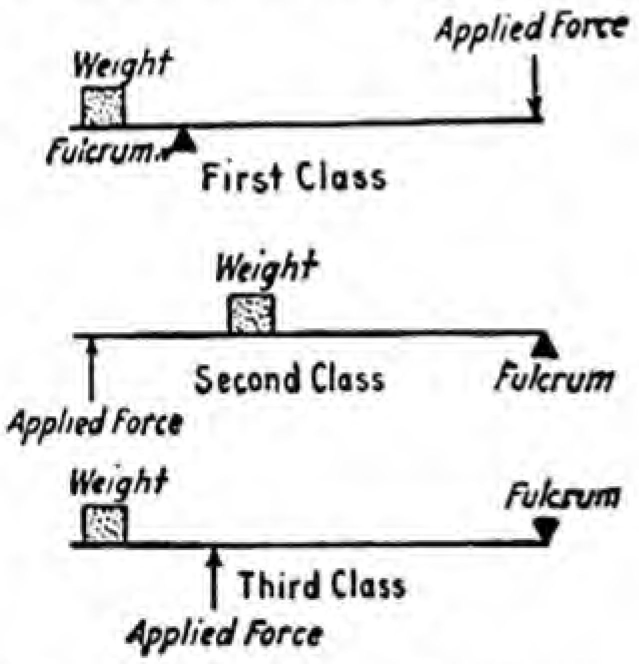


FIG. 1.—The three classes of levers.

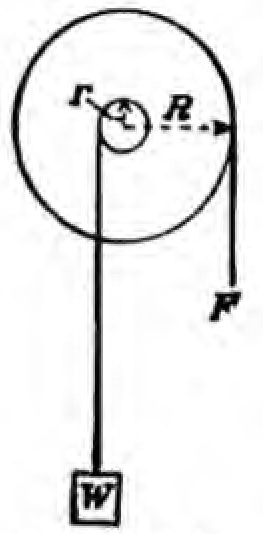


FIG. 2.—Wheel and axle.

A lever of the third class has the resisting force at one end, the fulcrum at the other, and the applied force between them. The mechanical advantage of this kind of lever is always less than unity, and, unlike the two previous classes, work is sacrificed for a gain in speed and distance. An ordinary crane is a lever of this kind.

14. The Wheel and Axle.—This is a modification of the lever and acts on the same principle, only the forces operate constantly (Fig. 2). The center of the axle corresponds to the fulcrum, the radius of the axle to the short arm, and the radius of the wheel to the long arm. The mechanical advantage is expressed by the equation,

$$F \times R = W \times r$$

where W = weight.
F = force applied.
R = radius of wheel.
r = radius of axle.

15. The Pulley.—A pulley consists of a grooved wheel turning freely in a frame called a *block;* it is a lever of the first or second class. There are several different applications of pulleys, depending on their arrangement.

A single fixed pulley affords no mechanical advantage except to change the direction of motion. When one or more fixed pulleys and one or more movable pulleys (Fig. 3) are used in combination, they form the block and tackle. The mechanical advantage varies directly as the number of ropes that support the movable pulley and the weight,

$$w \times h = F \times 3h$$

or

$$\frac{w}{F} = 3 \text{ theoretical mechanical advantage}$$

where w = weight.
h = distance weight moves.
F = force applied.
3 = number of ropes supporting w.

The differential pulley (Fig. 4) is a modification of a block and tackle but differs in that the two pulleys D and C are of different radii and rotate

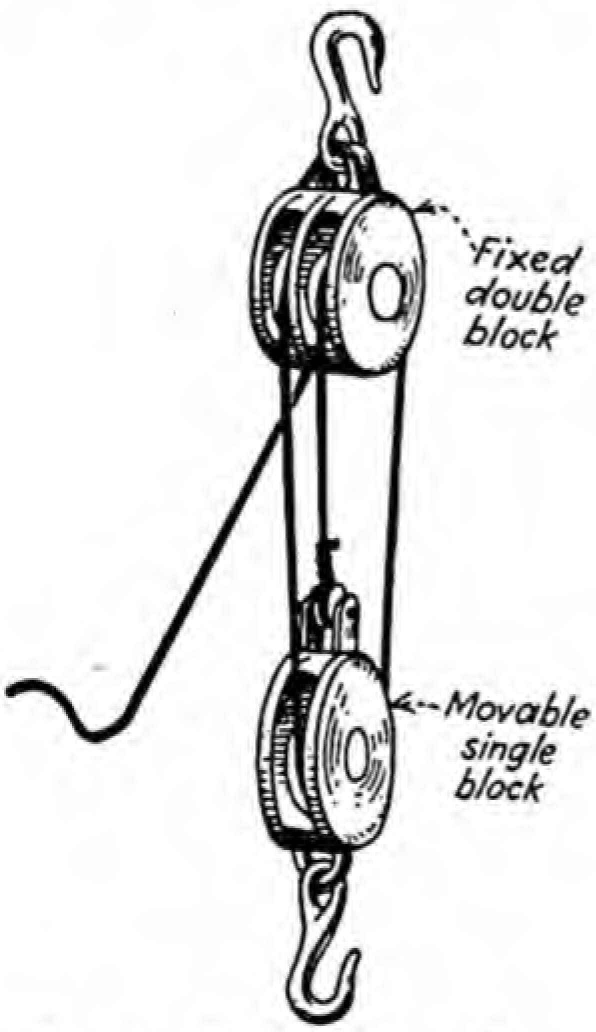


Fig. 3.—Block and tackle.

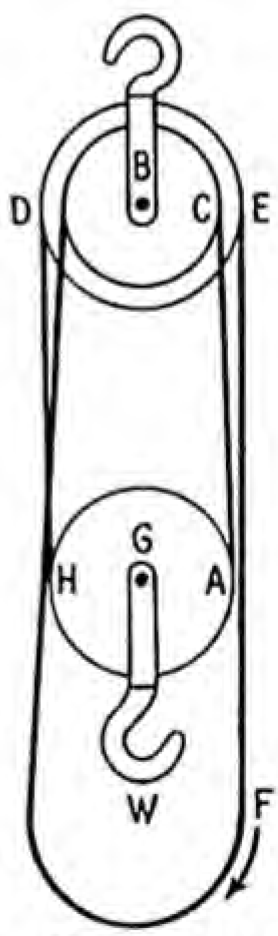


Fig. 4.—Differential hoist.

as one piece about a fixed axis B. The endless chain passes under and supports the movable pulley G and any weight attached to it. To raise a load, force is applied downward to chain F, which will rotate pulleys C, D, and G, causing the chain to wind up on the larger fixed pulley D and unwind on the smaller fixed pulley C, thus raising movable pulley G. In operation consider that point D of the section of chain DH moves up through an arc whose length is equal to BD. At the same time the point C of the section of chain CA will move downward an arc, a distance

equal to BC. The length of the chain loop $DHAC$ will be shortened to $BD - BC$, which will cause pulley G to be raised half this amount. P, the pulley force, is then applied to the section of chain EF, and the weight W is lifted at G. The mechanical advantage will be,

FIG. 5.—Geared differential hoists. A, worm-geared hoist; B, planetary-geared hoist.

$$P \times BD = W \times \tfrac{1}{2}(BD - BC).$$

16. The Inclined Plane.—The inclined plane, shown in Fig. 6, is an even surface sloping at any angle between the horizontal and the vertical.

The law or principle which governs the *inclined plane* in mechanics is that the force applied is increased as many times as the length of the inclined plane is greater than the elevation H. Briefly, it is equal to the length over the height, varying with the direction in which the force is applied. Instead of lifting the entire weight of the object vertically, part is supported on the plane and part by the force. Referring to Fig. 6, if the force F causes the weight W to move from A to C and parallel to the plane, the work done is F times AC, while the work done against gravity is the weight W times CE if friction is disregarded, or briefly,

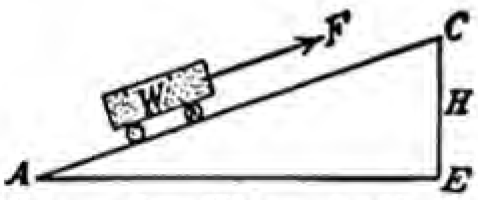


FIG. 6.—The inclined plane.

$$F \times AC = W \times CE.$$

If the force is parallel to the base AE, the advantage would be

$$F \times AE = W \times CE.$$

17. The Screw.—The screw (Fig. 7) is the application or modification of the inclined plane combined with the lever. The threads winding around a cylinder bear the same relation to the inclined plane that a winding staircase bears to a straight one. When the screw is turned on its axis with the aid of a lever or gear, its sloping thread causes the load to move slowly in the direction of its vertical axis. The vertical distance between threads is called the *pitch* of the screw.

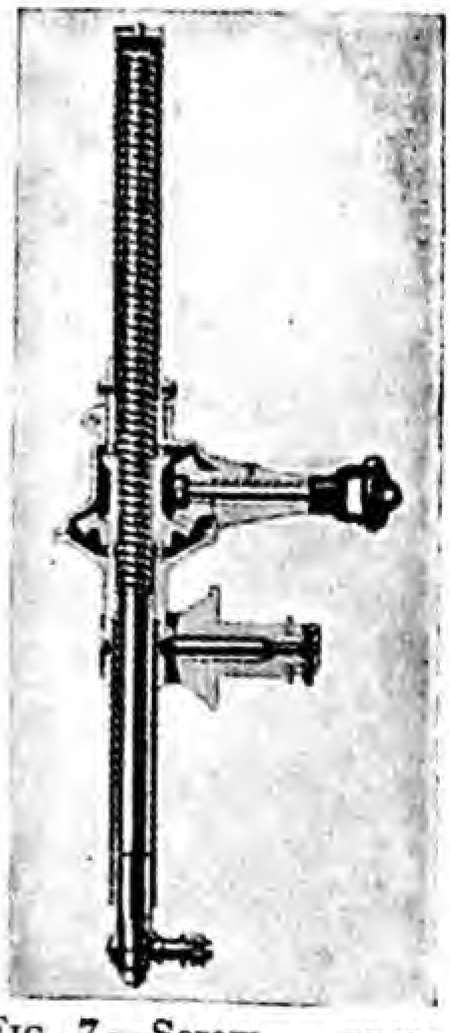


FIG. 7.—Screw operated by miter gears.

The mechanical advantage is figured upon the condition that the applied force moves through a distance equal to the circumference of a circle whose radius is the length of the jackscrew bar or the radius of the driving gear, while the weight is being moved through a distance equal to the pitch of the screw.

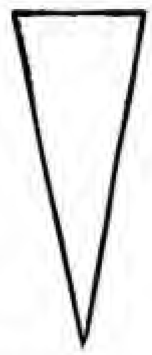


FIG. 8.—Wedge.

18. The Wedge.—The wedge is a modification of the inclined plane. Actually it consists of two inclined planes placed base to base (Fig. 8). The force pushing on the wedge into any material, such as a log, will cause forces to act perpendicular to each of the two faces of the wedge.

CHAPTER III

FRICTION AND ITS REMEDY

The chief cause for machinery wearing out is probably improper and insufficient lubrication. Much of this can be traced to the negligence of the operator, the poor construction of bearings, and the failure to provide adequate means of conducting the lubricant to the bearing units. Lubrication is needed because of friction.

19. Friction.—Friction is that force which acts between two bodies at their surface of contact so as to resist the sliding of one body on another. When any object is being dragged along upon any other object, friction between the two tends to stop the one that is being dragged. When one surface rests upon another, there is a tendency for the inequalities of the one to fit into those of the other, producing an interlocking not unlike that produced by putting the cutting edges of two saws together. If such interlocking has occurred, it is only possible to move one body over that of the other by separating them or by tearing off the interlocking surfaces. No matter how smooth the surfaces may be, there are still some elevations and depressions remaining which will permit a small degree of interlocking.

20. Rolling Friction.—When one body rolls upon another, the friction is much less than where one body is sliding upon another. The resistance in this case is called the *rolling resistance* or *friction*. This can readily be demonstrated by attempting to carry as much upon a sled which has no wheels as upon a wagon or any other vehicle mounted on wheels. Many farm implements are now using some type of antifriction bearing in the form of balls or rollers to diminish the amount of friction, which materially increases the efficiency of the machine. Friction in moving parts of machinery causes wasted energy and it is, therefore, desirable to reduce it to the smallest possible amount. However, in clutches or to prevent slippage of belts on pulleys, friction is necessary and useful.

21. Lubrication as a Remedy for Friction.—Lubrication tends to reduce friction. The theory of the action of lubrication is that a thin film of the lubricant adheres to, the bearing and another to the shaft, completely separating the metal surfaces. Then, these films slip one on the other, which reduces the amount of friction. This is because the friction of lubricants is much less than that between the metal parts. A

lubricant may act in different ways in reducing the amount of friction: first, by causing the greater part of the resistance to be due to the slipping of oil over oil; second, filling up the small depressions in the two frictional surfaces and in this way preventing the so-called *interlocking*.

22. Forms of Lubricants.—Lubricants are available in three forms: fluid oils, semisolids, and solids. Fluid oils are those that flow freely, such as gas-engine cylinder oils and oils used for lubricating various bearings by means of oil holes or oil cups. Semisolids include the soft greases, and transmission and differential grease. Solid lubricants consist of graphite and mica. Of these forms, soft greases and oils are most generally used to lubricate farm implements.

23. Kinds and Sources of Lubricants.—All lubricants have three general sources: animal, vegetable, and mineral. Animal oils are lard, tallow, and fish oils. Vegetable oils are cottonseed oil, castor oil, olive oil, and linseed oil. Mineral oils are oils obtained by refining crude petroleum. Of all these, mineral oils are the most universally used on the farm, because they can withstand higher temperatures without breaking down.

24. Use of Lubricants.—It is generally accepted that it is best to use the thinnest (or least viscous) oil that will stay in place and do the work. It naturally follows that a thin or light oil should be used for light work and as the load increases the lubricant should be heavier. Where the speed of the sliding surfaces is relatively high and the pressure of the bearing is not a heavy one, thin oil will render the best service. If the bearing carries a heavy load and slides slowly, heavy oil is best.

The number of revolutions per minute will determine the frequency with which lubricants should be applied. On a mower the main axle may not require oil more than once or twice during a day's operation, while the bearings on the crankshaft and pitman wheel need an application of oil every thirty minutes, at least.

Fig. 9.—Common grease cup.

Where greases or semisolid oils are used, the selection of the right grade of grease is important. Usually there are four grades: 1, 2, 3, and 4. The softest of these is No. 1, while the hardest is No. 4.

25. Grease Cups.—On farm machinery most of the slow-moving parts are lubricated by means of grease placed in cups with threaded caps (Fig. 9).

26. High-pressure Lubrication.—With the great improvement and modernization of farm machinery has come a change in the handling of machinery by the farmers who use it. Farmers today realize that equipment is no better than the care taken of it and that efficient farm machin-

ery now manufactured is capable of long hours of service only when kept well lubricated and in good operating condition.

The greater speed acquired through more powerful tractor engines and pneumatic tires would be lost unless the servicing of the machinery was

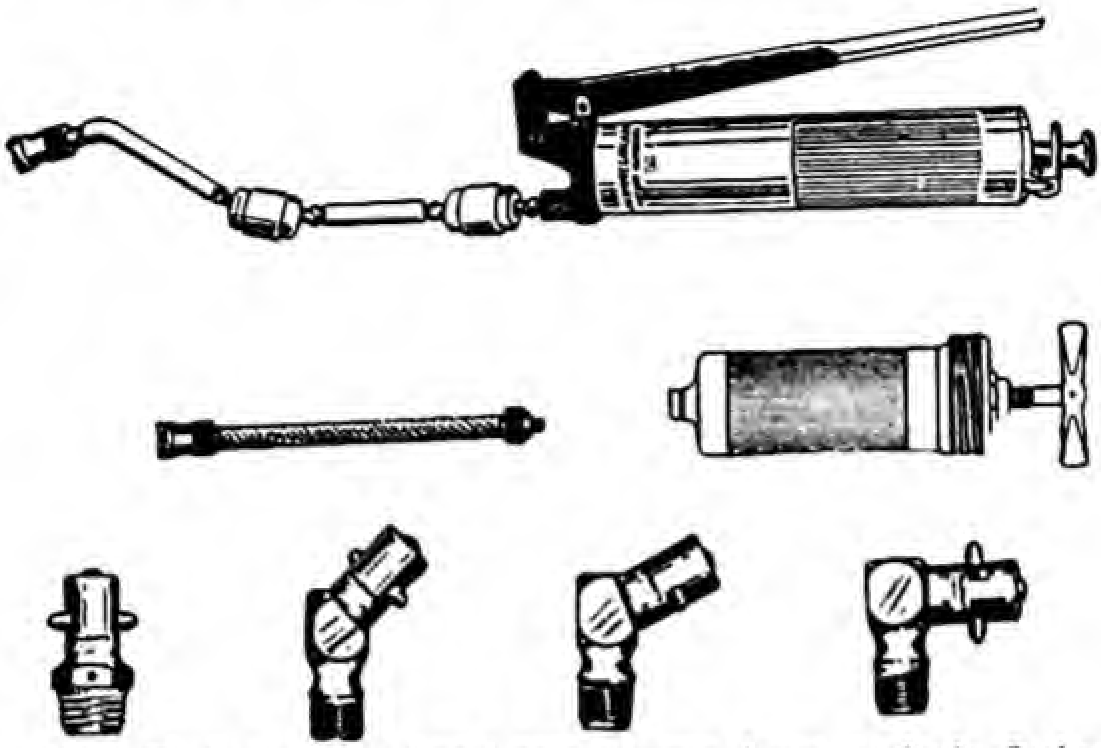


FIG. 10.—High-pressure hand grease guns, hose, and pin fittings.

done quickly, thoroughly, and effectively. Faulty lubrication would also soon extract an eventual toll in the form of breakdowns, which mean expensive repair bills and delays just when the machinery may be needed most.

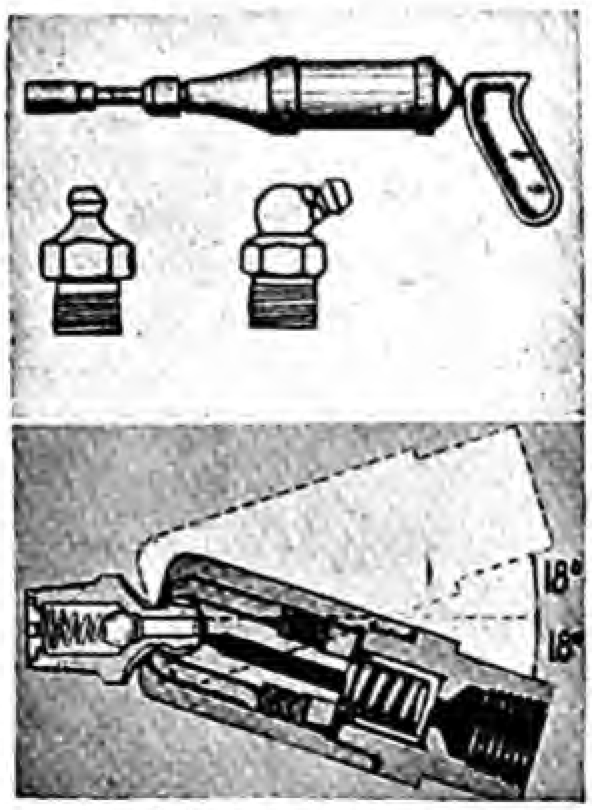
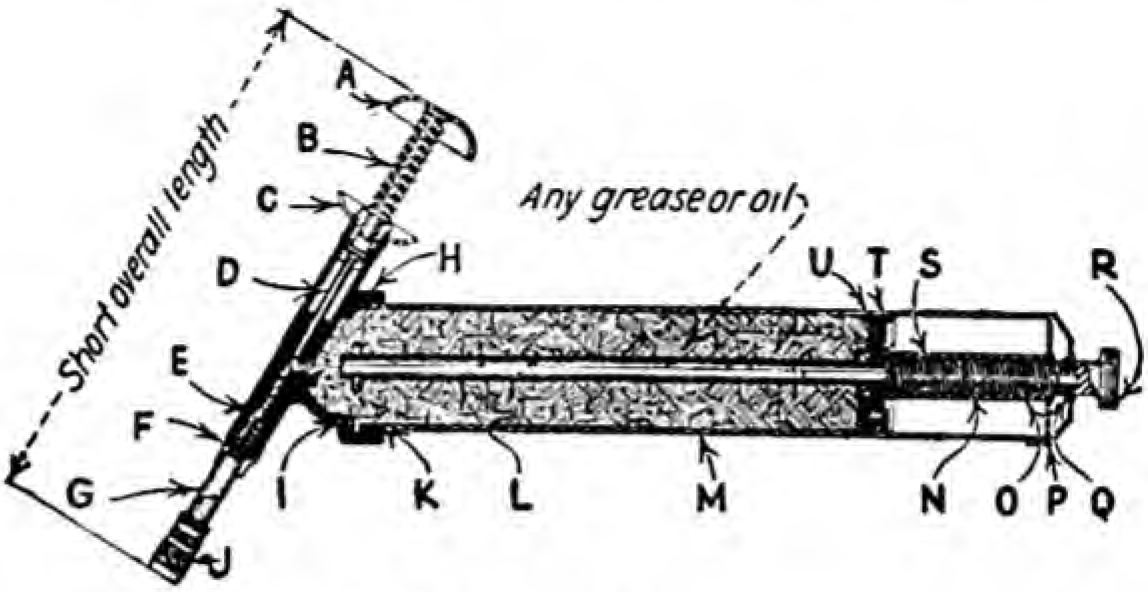


FIG. 11.—Hydraulic grease gun and fittings, showing cross section of nozzle and fitting.

Farm-machinery manufacturers realize the importance of good lubrication and are now equipping most farm machines with high-pressure fittings (Figs. 10 and 11). A survey of 5,000 farms has disclosed the use of 433 high-pressure fittings on the machinery on the average 80-acre



A Strong pressed steel handle
B Automatic spring return
C Pressed steel handle grip
D Closely fitted steel plunger, ground and polished
E Ball check valve
F Gasket seal
G Standard $\frac{1}{8}$" pipe easily changed to any special length
H Gun head casting, made of special alloy bearing metal
I Sealing gasket prevents leaks
J Nozzle for kleenseal, hydraulic, and all push type fittings
K Non-crossable thread
L Cold drawn steel follower rod
M Extra heavy wall steel tubing
N Positive priming spring
O Spring guide
P Strong pressed steel tube end
Q Locking pin that holds follower rod in barrel as shown
R Knurled steel knob
S Tempered steel spring, that pushes the follower entire length of gun barrel
T Extra cup leather, so gun barrel can be filled by suction
U Two(2) heavy duty grease and oil resisting cup leathers, with heavy steel follower on both sides

FIG. 12.—Cross section of Lincoln grease gun.

tractor farm.[1] These fittings are distributed on the various machines as follows:

	Fittings		Fittings
Tractor	20	Ensilage cutter	25
Tractor plow	12	Hay rake	12
Sulky plow	10	Hay loader	38
Disk harrow	12	Cultivator	12
Mower	7	Grain drill	30
Corn planter	10	Farm wagon	6
Windmill	2	Feed grinder	8
Manure spreader	17	Pump jack	2
Grain binder	40	Corn binder	40
Thresher	70	Automobile	20
Corn sheller	15	Truck	25

[1] Stewart-Warner Corporation, Alemite Division.

CHAPTER IV

MATERIALS OF CONSTRUCTION

The strength, durability, and service of a farm implement depend largely upon the kind and quality of material used in building it. There is a tendency at present in the construction of implements to eliminate as many castings as possible and to use pressed and stamped steel. Where this is done, the cost of manufacturing machinery in quantities is materially reduced. The weight of the machine is reduced but the strength and durability are retained and often improved. The success or failure of an implement frequently depends upon the material used in building it.

27. Wood.—Today iron and steel have practically taken the place of wood. There are perhaps two reasons for this: first, steel is more durable; second, it is becoming cheaper than good wood because of the scarcity of the latter. Many farm machines are defective because the wood used in their construction is not well cured and free from knots. The wood parts should be well painted.

28. Cast Iron.—Cast iron is iron containing so much carbon or its equivalent that it is not usefully malleable at any temperature. The amount of carbon varies from 2.2 to 4.3 per cent, depending on the amount of silicon, sulfur, phosphorus, and manganese.

There are two grades of cast iron—gray cast iron where the carbon is segregated from the iron in the form of graphite, and white cast iron which has carbon and iron combined. Another grade is often mentioned, mottled cast iron, which is a mixture of the gray and white. Cast iron is made by combining pig iron and scrap iron and pouring the molten metal into sand molds of the desired shape, where it is allowed to cool before it is cleaned and made ready for use.

Cast-iron castings are generally large, bulky, and very brittle. They cannot be hammered to any great extent without breaking. They cannot be forged but can be cemented together by brazing or welding. The brazing process is accomplished by heating the broken parts to a welding heat and applying a brazing compound. Welding is accomplished by using an oxyacetylene gas flame.

29. Malleable Cast Iron.—Malleable iron is annealed white cast iron in which the carbon has been separated from the iron without forming flakes or graphite as in gray cast iron. It will bend to a limited extent without breaking.

The process of making malleable cast iron consists of melting the white pig iron, with scrap, in the furnace and pouring it rapidly into sand molds while very hot. After cooling, the castings are cleaned and made ready for annealing. The annealing pots are usually of cast iron. The castings are packed in these pots along with iron scale (iron oxide) which acts as a decarburizer and causes much of the brittle quality to disappear. The annealing pots containing the castings and iron scale are placed in an oven and the temperature raised to a cherry-red heat, about 1450° F., and held there from 3 to 5 days, depending on the size of the castings and the amount of decarbonizing desired. Then the furnace is allowed to cool slowly for a few days before the castings are removed and cleaned. Malleable cast iron is used extensively in building farm machinery and for various kinds of hardware.

30. Chilled Cast Iron.—Chilled cast iron is cast iron poured into molds that have a part of the mold made of metal instead of sand. This metal causes the molten iron that comes in contact with the metal to cool more rapidly than the balance of the casting, thus forming a hard surface. The metal portion of the mold must be heated to a temperature of about 350° F. before pouring to prevent explosions when the hot metal strikes the cold. Chilled-cast-iron moldboards for plow bottoms show that the iron fibers are brought perpendicular to the surface where the metal is chilled.

31. Wrought Iron.—Wrought iron is nearly pure iron, with some slag, and is used in forge work as it is readily welded and easy to work. Wrought iron has very little carbon in it, ranging from 0.05 to 0.10 per cent. It is expensive, however, and a mild steel is used to a considerable extent in place of it. The commercial form is obtained by rolling the hot iron into bars or plates from which nails, bolts, nuts, wire, chains, and many other products are made.

32. Steel.—Steel is a variety of iron classed between cast iron and wrought iron, very tough and, when tempered, hard and elastic. The hardness of steel is determined principally by its carbon content but is influenced by the percentage of manganese, phosphorus, and sulfur. The American Society of Automotive Engineers has a numeral index system which is used to identify the composition of the various grades of carbon, manganese, nickel, molybdenum, chromium, chromium-vanadium, and tungsten steels. For example, a mild carbon steel carries an A.S.E. No. 1020 and contains 0.15 to 0.25 per cent of carbon. A medium carbon steel is numbered 1045 and contains 0.40 to 0.50 per cent of carbon. High-carbon spring steel is A.S.E. No. 1095 and contains 0.90 to 1.05 per cent of carbon. In manganese, nickel, molybdenum, and

other steels extra percentages of these elements are added to impart toughness and other special properties.

Steel that comes in the form of angle irons, I-beams, channels, tee bars, round and square rods, tubes, plates, and strips, as shown in Fig. 13, is known as *structural steel*. The steel used in these pieces is made by one

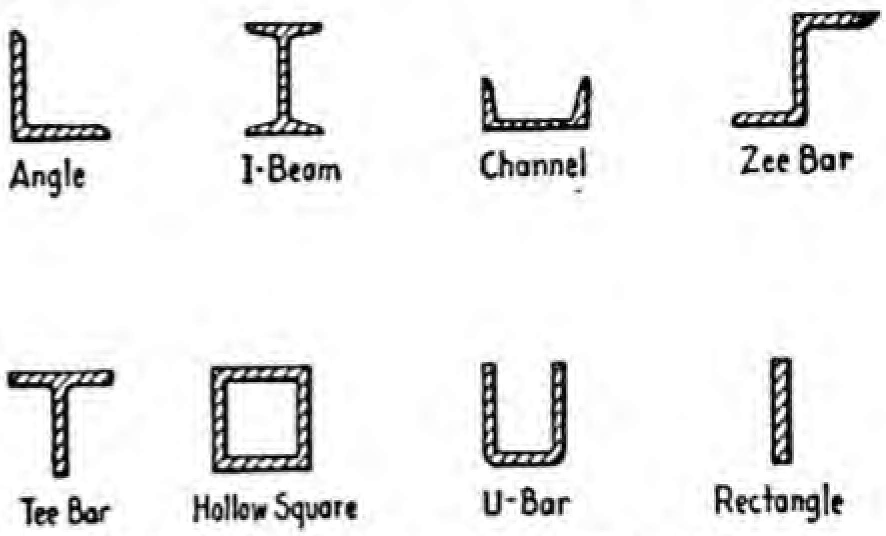


FIG. 13.—Types of structural steel.

of two processes, open-hearth and bessemer. The former process gives the best grade of material but is more expensive; hence, in agricultural machinery the latter kind is generally used. The steel is first made into large bars and then rolled into the various shapes.

33. Soft-center Steel.—Soft-center steel consists of three layers of steel, as shown in Fig. 14; two layers of hard steel are placed on the outside and welded to an inner layer of soft steel. In this manner a hard surface

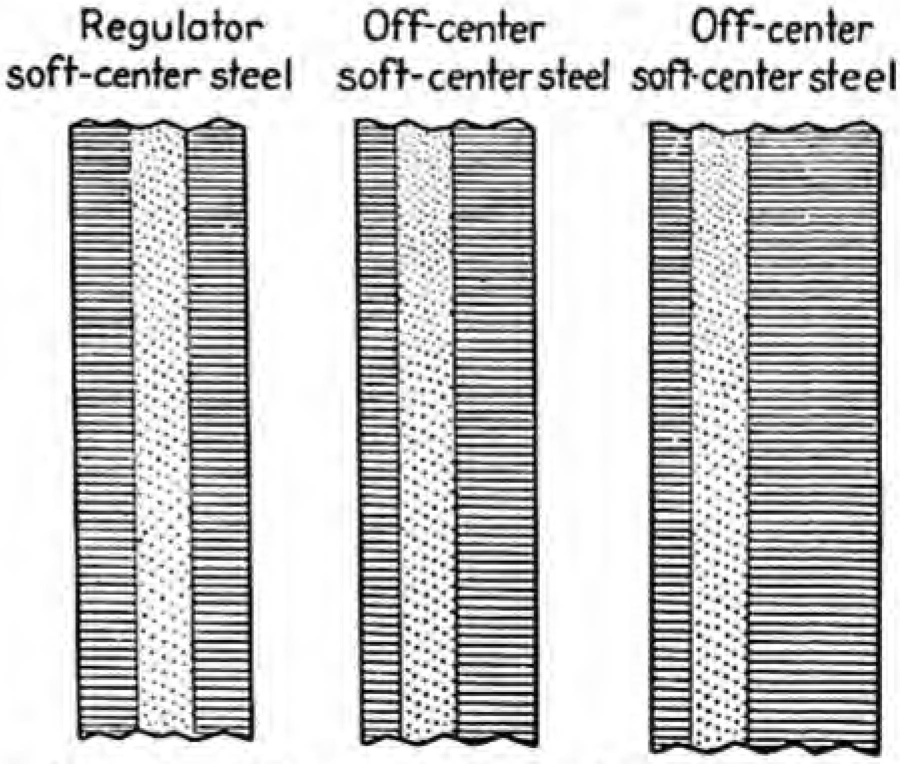


FIG. 14.—Different types of soft-center steel.

is obtained without brittleness. Soft-center steel is used on plow bottoms. Filing a slight notch in the edge of the metal will reveal the three layers of metal.

34. Casehardened Steel.—This steel closely resembles soft-center steel since the outer surfaces are hardened, leaving a soft center. It is

made by heating soft or mild steel in contact with carbon so that the carbon will penetrate the outer skin, making a high-carbon steel surface which is very hard. The objection to this type of soft-center steel is that the hardened surface is not of uniform depth. The surfaces of cams are usually casehardened.

35. Cast Steel.—Cast steel is a steel that is cast. It can be secured in varying degrees of hardness and makes a more durable casting than the best grade of cast iron. It is used mostly in gearing. Not much of it is found in agricultural machinery.

36. Brass.—Ordinary brass is an alloy of copper and zinc. Some commercial brasses contain small percentages of lead, tin, and iron. The percentage of copper in brass may range from 60 to 90 per cent, and the percentage of zinc from 10 to 40 per cent.

FIG. 15.—Casehardened steel.

37. Bronze.—Bronze is an alloy of copper and tin. However, zinc is sometimes added to cheapen the alloy or change its color and increase its malleability. The amount of tin in bronze may vary from 5 to 20 per cent. Phosphor-bronze, manganese bronze, and aluminum bronze are special copper alloys containing small percentages of tin, zinc, or aluminum.

38. Babbitt.—Babbitt is a tin-base alloy containing small amounts of copper and antimony. Good babbitt for automobile bearings should contain 7 per cent copper, 9 per cent antimony, and 84 per cent tin.

39. Solder.—Common solder contains about one part tin and one part lead. Hard plumber's solder contains two parts tin and one part lead.

HEAT-TREATMENT OF MATERIALS

Heat-treatment is a term used when heating and cooling processes, through a range of temperatures, are applied to steel to improve the structure and produce desirable characteristics. Such treatments include annealing, hardening, tempering, and casehardening.

Plow beams, plow disks, and disk-harrow blades are examples of parts of agricultural machines that are heat-treated in order to make more serviceable implements.

CHAPTER V

TRANSMISSION OF POWER AND ELEMENTS OF MACHINES

It is not always possible to transmit power by one continuous shaft directly from the source at which it is generated to the point where it is consumed. It is necessary, therefore, to have some other means by which power can be transmitted in order that work may be done. The principal methods used are belts in connection with pulleys and shafts, sprockets and chains, gears, triangles, and electricity.

In the study of farm machinery it is necessary to notice a good many points that cannot always be brought out in the discussion of the individual machine. These elements of a machine include such things as bearings, bushings, gears, clutches, and the various minor parts that will have an influence on the value and the lasting qualities of the machine.

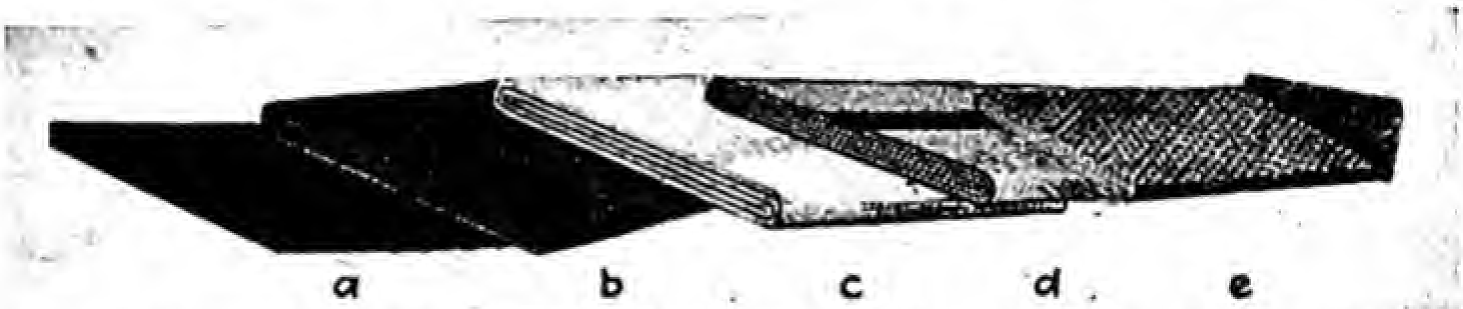


FIG. 16.—Different kinds of belting: *a*, leather; *b*, stitched canvas; *c*, balata; *d*, rubber; *e*, solid woven.

40. Belts.—Whenever it is necessary to transmit power some distance between shafts or from some point where it is not possible to use a set of gears, belting is used. The purpose of a belt drive is to carry a certain amount of power from one revolving pulley to another. Therefore, a good definition for a belt may be given as follows: A belt is any flexible material placed around two pulleys, having a certain amount of tension, to transmit the power from one pulley to another. Such a definition, of course, includes ropes and chains, since they are of flexible material, but in the true sense of the word, we always think of them as "chain belts" or "rope belts," and the term *belt* is always applied to the flat strand of leather, rubber, canvas, or other similar material stretched on pulleys.

41. Kinds of Belts.—The different kinds of belts used by the average farmer are leather, rubber, canvas, and woven cotton (Fig. 16). It is generally considered that the leather belting is the best type that can be secured. It is also the most expensive, but it has longer life than any of the other kinds if it is given proper care and protection.

42. Leather Belting.—Leather belting should be used only under the best conditions, that is, it should be kept dry and in a protected place, free from grease, dirt, and oil. Single leather belting is only one thickness; double leather belting is composed of two thicknesses cemented together. Double leather belts are made for special purposes and can be used to advantage only over extra-large pulleys. It is generally advisable to use single leather belting if one, or both, of the pulleys is less than 12 inches in diameter and double leather belting where both pulleys are over 12 inches in diameter. If the belt has been spliced, it should be placed on the pulley to run in such a direction that the *thin edge* of the splice will be on the *inside of the belt*, and the first part of the splice will run over the pulley. The splice of the double belt should run with the thin edge pointing away from the direction of travel.

In placing leather belts on the pulley, always place the *hair side* next to the pulley, for this gives less slippage. When run in this manner the flesh side, the softest part of the belt, is not so liable to crack. Also, the hair side is much smoother and more friction can be obtained between the belt and the pulley surface, thus eliminating slippage to a large extent. Jones[1] found that the hair or grain side would transmit from one to three times as much power as the flesh side, depending on the belt, the tension, and the condition of service.

43. Rubber Belting.—The next best type of belt that can be secured is the rubber belt (Fig. 16). It has uniformity in thickness, will stand variation in temperature without being injured greatly, and is not affected by the action of steam and water. There is not so much belt slippage as in the case of the leather belt; hence, less tension is required and the bearings of the machine are not subjected to such heavy strains. It wears out more rapidly, however, especially if the edges are rubbing against any object. There is also the disadvantage that it will stretch, so that the distance between the pulleys will have to be regulated or the belt cut and relaced for good operation. The foundation of rubber belting consists of cotton ducking which is specially treated with a rubber compound. The compound is applied and forced into the ducking by pressure. The whole is then vulcanized and placed under a very heavy pressure which removes all superfluous stretch and unites the rubber and duck into one inseparable body. It is generally considered that a three-ply rubber or a four-ply cotton belt is equal in strength to a single-ply leather belt, and a six-ply rubber belt is equal to a double leather belt.

In the making of the rubber belt the layers of canvas ducking are often folded over and stitched along the edges. The vulcanizing of the

[1] The Leather Belting Exchange.

rubber to the canvas is supposed to hold the central part of the belt together; however, this is not always effected. If the edge of the belt happens to rub against the tractor wheel, axle, or some other object

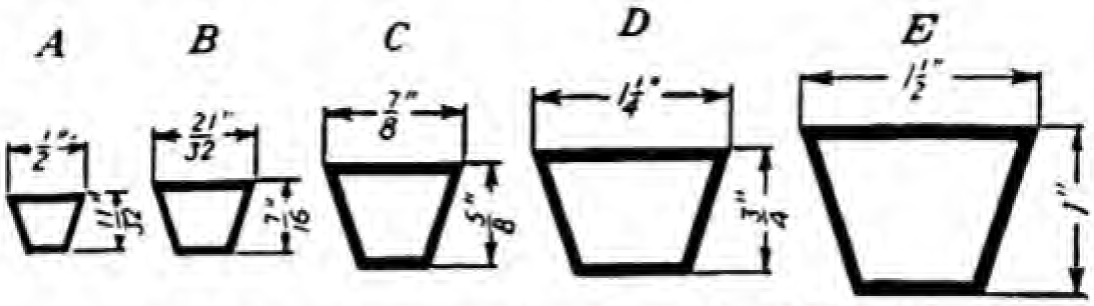


FIG. 17.—Cross section of standard V-belts.

and wears the stitching away, one complete fold of the belt may hang loose. When this happens, the life of the belt is shortened.

44. Canvas Belting—Canvas belting (Fig. 16) is made up of layers of canvas stitched together through the center as well as along the edge. It is a cheap belt and is used where rough handling is expected. It is not

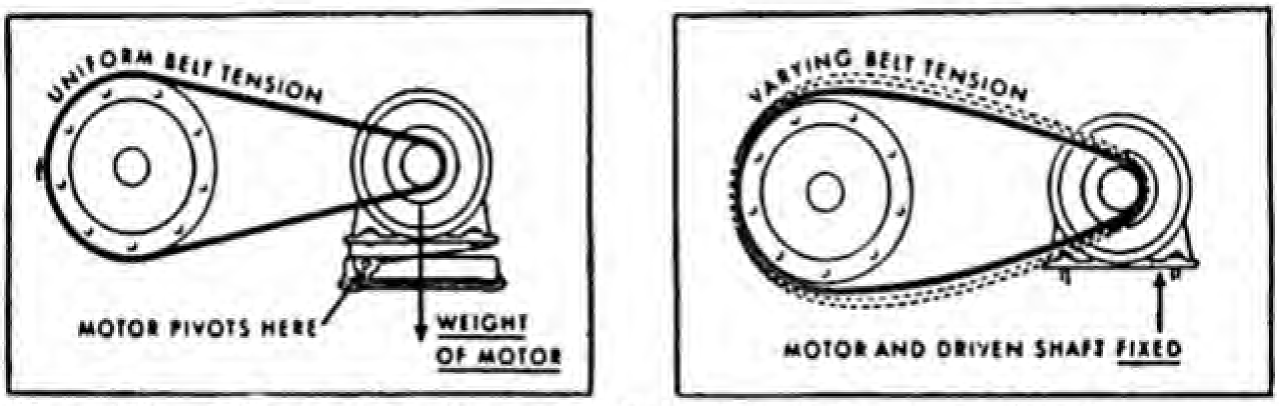


FIG. 18.—Effect of tension on V-belts by pivoted and fixed motors.

adapted for use over pulleys having fixed distances between them but should be used where distance between pulleys can be adjusted with little difficulty, for example, running threshing machines, ensilage cutters, and similar machines. A four-ply canvas belt is of the same strength as a single-ply leather belt. A thick, heavy canvas belt should never be used on small pulleys.

45. Solid Woven-cotton Belts.—The woven-cotton belt (Fig. 16), instead of being made up of layers of canvas ducking, is woven somewhat in the same manner as an ordinary lamp wick. It is made in various widths and weights, proportional to the service required. It is treated with a special material to withstand friction, dirt, and atmospheric conditions.

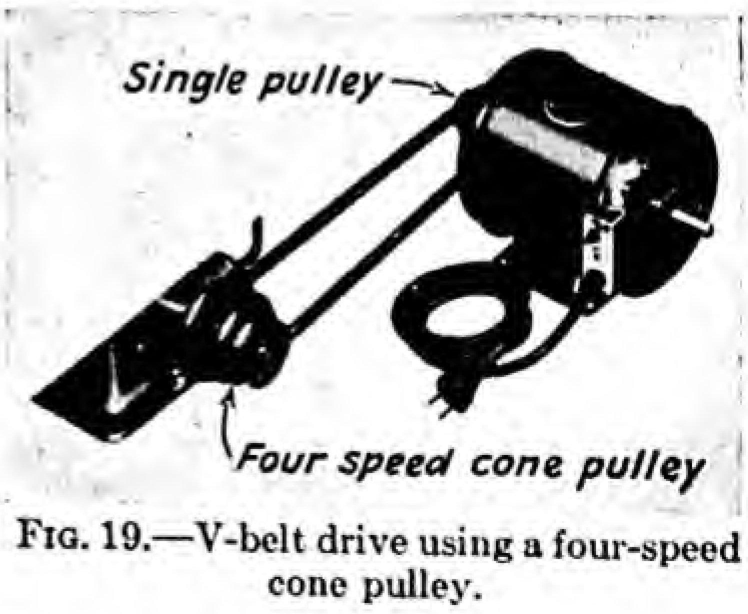


FIG. 19.—V-belt drive using a four-speed cone pulley.

46. V-belts.—V-belts are so named because of their shape (Fig. 17). The pulley for this type of belt has a V-shaped groove (Fig. 19) to fit the belt. The V-belts proved their serviceability as fan belts on automo-

biles, and as a result they have been adapted for use on many farm conveniences and some farm machines. Combine harvester-threshers are equipped with V-belts and adjustable pulleys. Fans on feed mills are driven with a series of from three to four V-belts. Less slippage is encountered with V-belts used in grooved pulleys than with flat belts on crown-faced pulleys.

47. Belt Lacing.—The most common type of belt lacing for ordinary farm usage is the leather lacing. The methods of lacing belts are a single straight lace, double straight lace, and double hinge lace. The following are good rules for lacing belts:

1. For belts 2 to 10 inches wide, place the holes ½ to ¾ inch from the side and ⅞ inch from the end of the belt. The second row should be at least 1¾ inches from the end. For wider belts these dimensions should be even greater, the longer diameter of the holes being parallel with the side of the belt.
2. Holes in rubber and in the different types of canvas belts should be made with a sharp belt awl. Holes in leather belts should be made with an oval punch.
3. For light work with large pulleys use the single straight lacing.
4. For heavy work with large pulleys use the double straight lacing.
5. For lacing rubber and canvas belts doing heavy work on large or small pulleys use the double hinge lacing.
6. The straight part of the lacing should always be on the pulley side of the belt.

Metal laces for small belts transmitting a small amount of power are quite satisfactory. Figure 20 shows two types of metal belt laces.

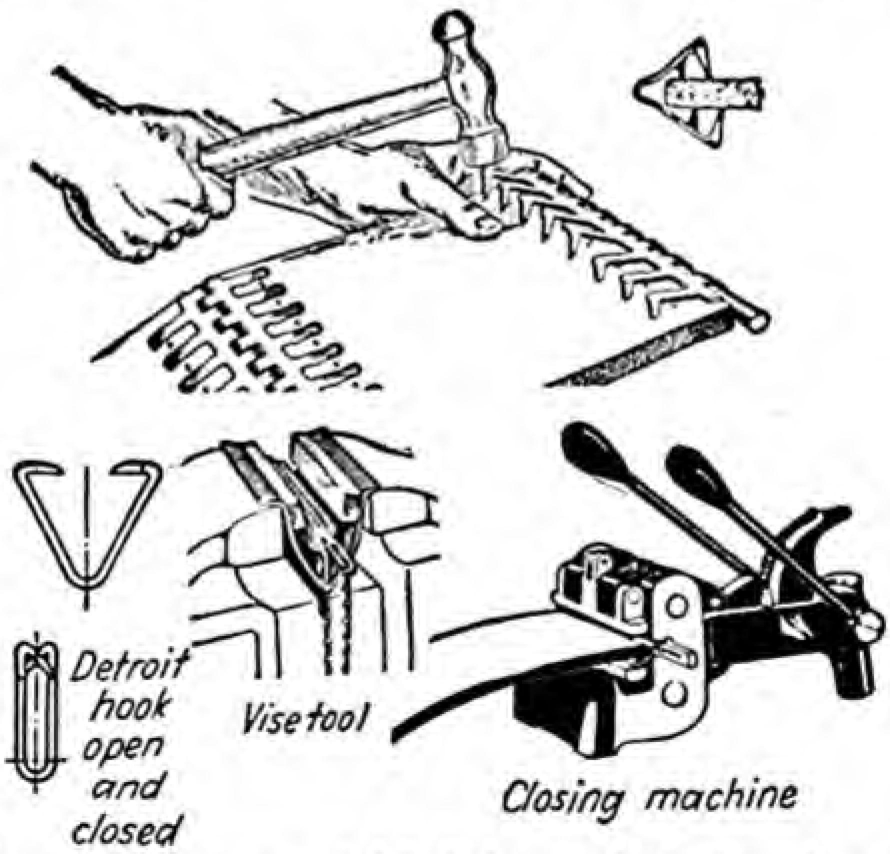


FIG. 20.—Methods of closing metal belt laces: Alligator *above*, Clipper *below*.

48. How to Lace a Belt.—Figure 21 shows a simple method of lacing an ordinary belt. Begin in the middle of the belt, lace to the edge, then back to the middle. Fasten the ends in the middle. Beginning on the pulley, or hair side, put one end of the lace through hole 1 from hair side to flesh side. Put the other end of the lace through hole 2 from hair side

and draw tight. Pass long end of lace diagonally across the joining and through hole 3. From hole 3 pass lace straight up on hair side and through hole 4; then, diagonally down on flesh side and through hole 5; then, straight up on hair side to hole 6, down on flesh side to hole 7; up on hair side to hole 8, down diagonally on flesh side to hole 9; straight up on hair side to hole 10, and diagonally down on flesh side to hole 11. Continue in the same way, placing the lace through the various holes in order.

49. Belt Creep and Slip.—When a belt is running under a load, it is impossible for 100 per cent of the power available at the driving pulley to be delivered to the driven pulley. The slight difference in the revolutions per minute of these pulleys is due to the slipping of the belt. When transmitting power, there is a tight and a slack side to the belt. The tight side stretches while the slack, in turn, contracts. The section passing on to the driving pulley is slightly longer than that passing off. The reverse is true at the driven pulley. The change in length, which takes place while the belt is on the pulleys, is called *creep* and should not be confused with slip.

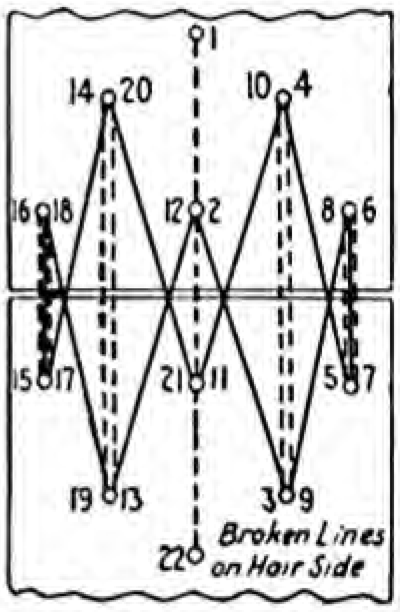


Fig. 21.—Method of lacing a flat belt.

50. Some Useful Rules on Belts.—To find the horsepower a leather belt will transmit: If V equals the velocity of the belt in feet per minute and W equals the width of the belt in inches, for a single belt horsepower equals $VW/1{,}000$; for a double belt horsepower equals $VW/550$.

To find the length of a belt for two pulleys: Add the diameters of the two pulleys together, divide this sum by 2, multiply this quotient by $3\frac{1}{7}$ and to this product add twice the distance between the shafts.

To calculate the speed or size of pulley: The r.p.m. of the driving pulley times its diameter equals the r.p.m. of the driven pulley times its diameter. If three of the quantities are known, the fourth can be easily determined. $S \times D = S_1 \times D_1$, where S = r.p.m. and D = diameter.

To find the speed of the belt: Multiply the circumference of the pulley by the number of revolutions at any given time. This disregards slippage and creep. The speed of the belt should not exceed 5,000 feet per minute. A good speed is around 3,500 to 4,000 feet per minute.

51. Some General Precautions as to the Use of Belts.

1. Belts that are too tight cause injurious strains on the belts and machinery that result in hot boxes and broken pulleys.
2. Belts that are too loose have a flappy, unsteady motion.
3. All belts should be kept free from dirt and moisture.
4. Mineral oils should not be used on leather and rubber belts.
5. Boiled linseed oil or resin mixed with tallow and oil makes a good belt dressing.

6. Belts should be run horizontally or as nearly so as possible.
7. The lower side of a belt should be the driving side, as it gives a greater arc of contact (Fig. 22).
8. Idler pulleys should be placed on the slack side of the belt and nearer to the driven pulley (Fig. 22).
9. The arc of contact should be 180 degrees and over if possible (Fig. 22).
10. A pulley that is too narrow should never be used.

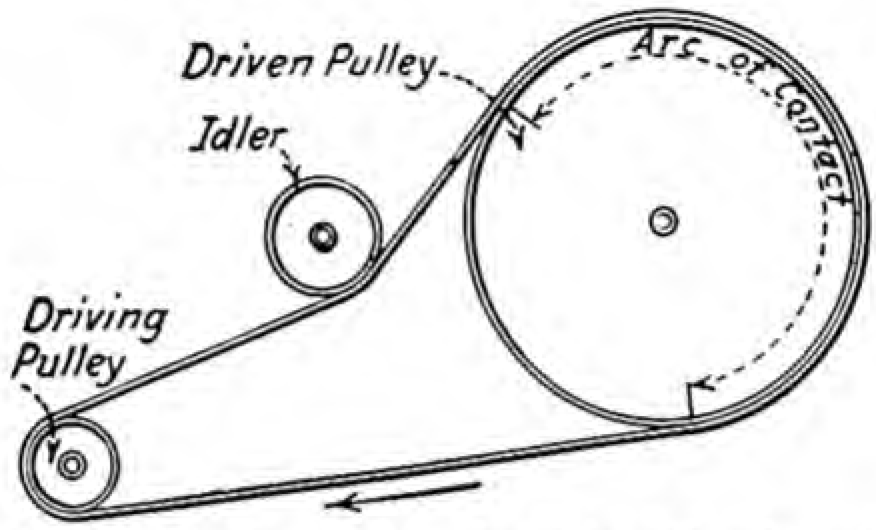


Fig. 22.—Method of placing idler on a belt; the tight side of the belt should be on the bottom.

52. Care of Belts.—The United States Department of Agriculture, *Farmers' Bulletin* 1183, gives the following on the care of belts:

Satisfactory service cannot be expected from a belt that is too light or too heavy or otherwise not adapted to the work. Neither can a belt be made to give satisfactory results if the slips do not run true; if it is not properly laced; is run too loose or too tight; is subjected to alternating light and heavy loads; is alternately wet and dry; is run on pulleys of the belt; or is neglected and allowed to deteriorate for lack of grease and belt dressing. Unless frequently wiped off, dust and dirt work into the belt and damage it. Never let the belt remain dusty or dirty overnight or leave an excessive amount of grease or oil on it.

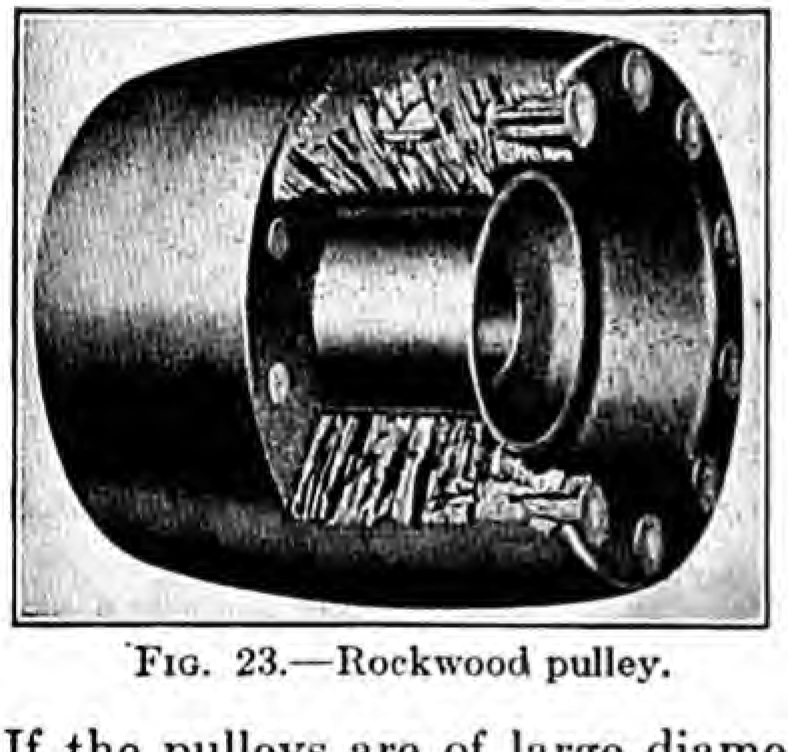


Fig. 23.—Rockwood pulley.

The best leather-belt dressings are mixtures of cod-liver and neat's-foot oils with tallow and wool grease free from mineral acid.

53. Pulleys.—Pulleys for agricultural purposes are manufactured from wood, cast iron, and pressed paper. If the pulleys are of large diameter and not exposed to steam or water, and if slow speed and light power are required, wood is still extensively used. Size for size, the wooden pulley is perhaps a little cheaper, but the transmission of power by the cast-iron pulley will cost less. A special type of pulley known as the *Rockwood* pulley (Fig. 23) is popular for use on machines that run at a high speed.

Figure 24 shows an adjustable pulley where the speed of the driven machine can be either increased or decreased by varying the distance between the sides of the V-pulley. This changes the arc of contact between the pulley and the belt, thus varying the speed.

FIG. 24.—Variable-speed pulley.

54. Method of Constructing Pulleys.—There are the following types of pulleys: solid, split, and split-hub.

The *solid pulley* is cast in a solid piece, with setscrews and keys to fasten it to the shaft. It is better balanced in weight than the other types but has the disadvantage of having to be slipped on over the end of the shaft to the position required. If the shaft is already up and another pulley is needed, the removal of all pulleys and collars may be necessary to get it in place. Solid cast-iron pulleys cannot be used to any advantage with a different size of shafting than that for which they were bored.

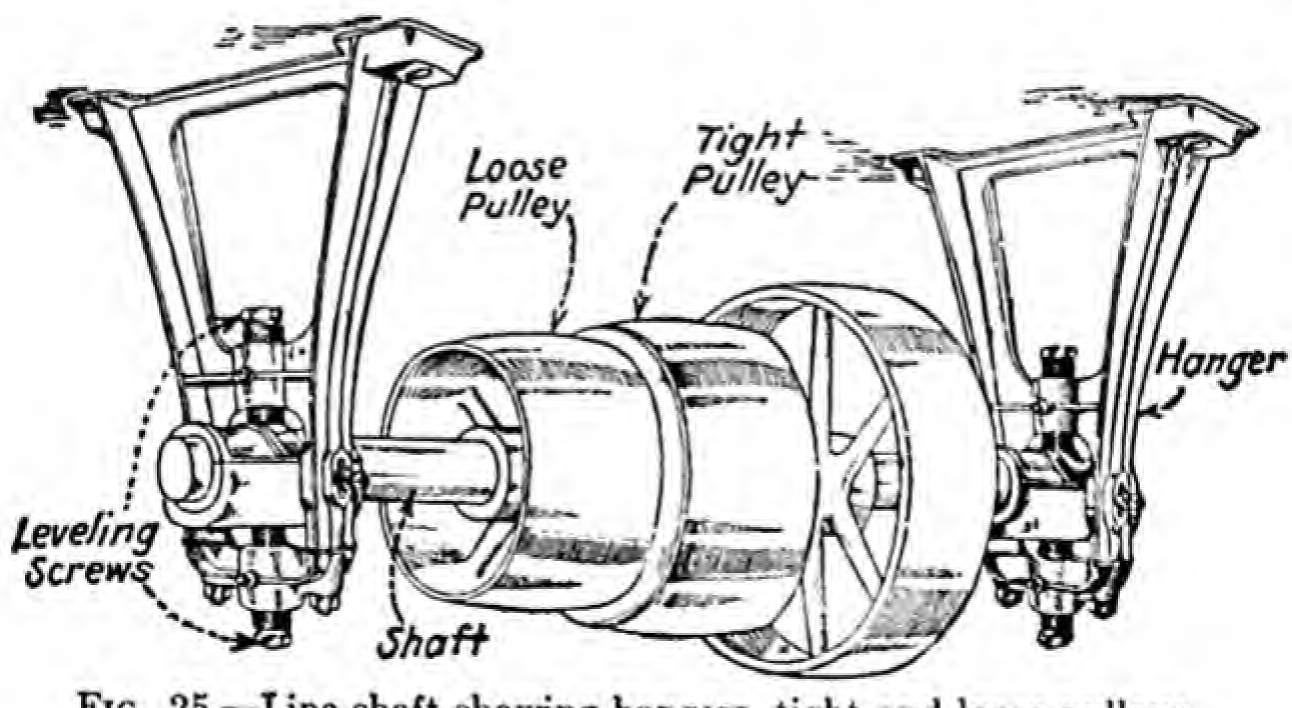


FIG. 25.—Line shaft showing hangers, tight and loose pulleys.

The *split pulley* is divided into halves that are held together by bolts. This type of pulley may be had in either wood, cast iron, or steel. The halves are built separately, fitted together, and then finished as a solid pulley. This type of pulley depends upon the binding effect of the bolts to prevent turning on the shafts. Often a key or a setscrew is added to aid the bolts. Such a pulley can be put on at any place on the shaft without disturbing the equipment previously installed.

The *split-hub pulley* has a solid pulley face but a split hub. It has about

the same disadvantages as the solid type. The split hub allows slight adjusting for different-sized shafts. Bolts through the hub clamp the pulley onto the shaft. This type is not much used, except at the ends of shafts, on gas engines, and for power pulleys such as are used on threshing machines.

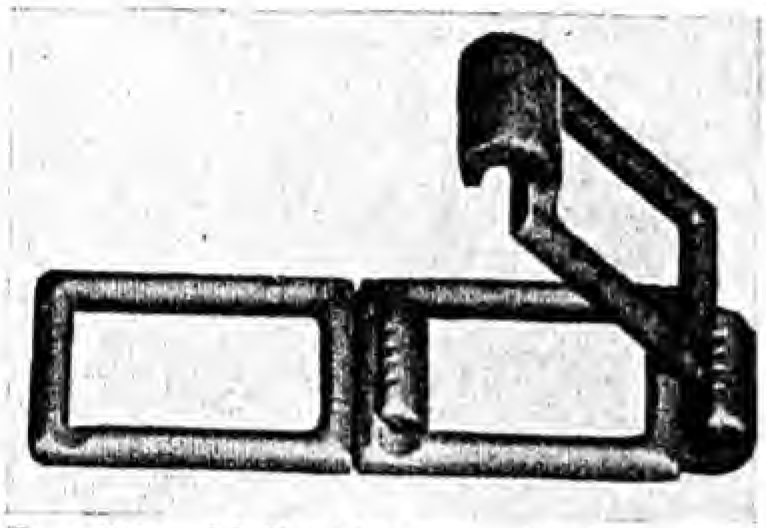


FIG. 26.—Malleable-iron hook chain showing how to separate links.

The center of the pulley face is generally slightly larger in diameter than the edges and is called *crowned* (Fig. 25). This gives a greater centrifugal force and a greater speed, causing the belt to hang to the point of larger diameter—the center of the pulley.

Many pulleys, where the belts need guiding, are built with a flange on one side. The flanged edges should be rounded to prevent cutting the belt in case it runs up over the flange.

55. Line Shafting.—The shaftings on agricultural machinery are usually made from cold-rolled steel which comes from the mill in the finished form. The factories cut it into the required lengths, milling keyways wherever needed.

A line shaft, as shown in Fig. 25, consists of a long continuous shaft supported by *hangers*. Arranged upon this line of shafting are pulleys for transmitting power to separate machines. The hangers for shafting

FIG. 27.—Pressed-steel hook chain.

should not be placed over 8 feet apart. The size of the cold-rolled shafting to be used can be determined by a formula. It usually is a better plan, however, for average farm conditions, to give the dealer the amount of horsepower to be transmitted and let him furnish the proper size of shafting needed.

The journal of a shaft is that part which is in contact with the bearing.

56. Power Transmission by Sprocket and Chain.—Where power is to be transmitted at low speed, chain or link belting is very useful. There is no slippage when a chain belt is used and much more power can be transmitted for short distances than with an ordinary type of belt. When

the links and the teeth on the sprocket wheel begin to wear, however, there is a tendency for the chain to ride the sprocket teeth and sometimes to jump off entirely. Figures 26 to 29 show the kinds of chains in common use for transmitting power. They are made from either malleable iron

FIG. 28.—Detachable pintle chain.

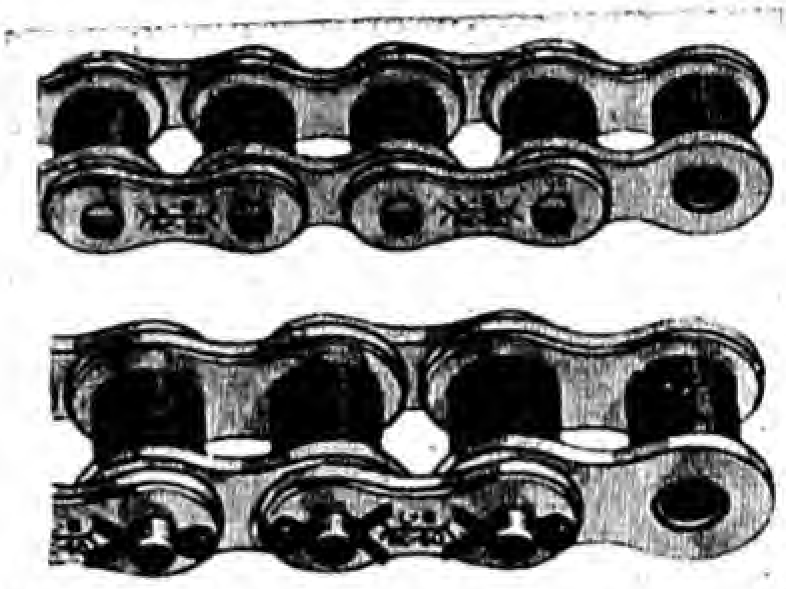


FIG. 29.—Two types of roller chain.

or steel. In a *pintle chain* (Fig. 28), the links are held together by pins or rivets. Such chains are usually made of malleable iron. If there is a roller fitting over the pin to form a bushing and to serve as a wearing surface, it is called a *roller chain* (Fig. 29). This is really the better type

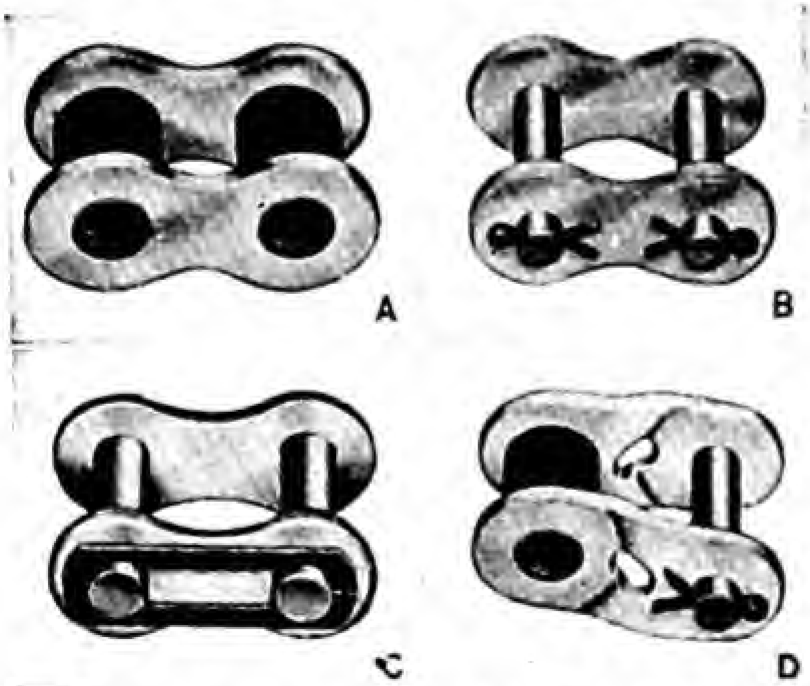


FIG. 30.—Roller-chain parts: *A*, inside roller link; *B*, connecting outside link; *C*, spring clip connecting outside link; *D*, offset or half link.

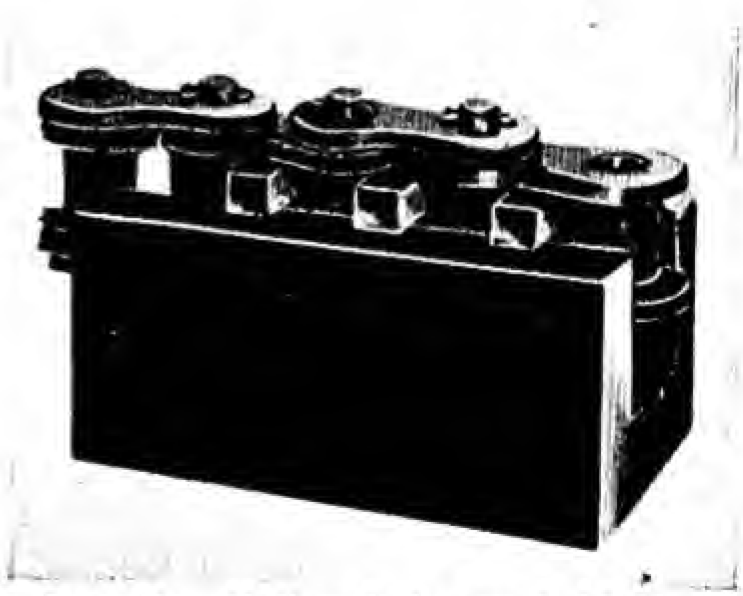


FIG. 31.—Roller-chain repair block.

of chain to use since it partly substitutes rolling for sliding friction and also distributes the wear over a larger surface, running a longer time without giving trouble. It is also used for transmitting power at high speeds. The *hook chain* may be made of either malleable iron or crimp steel

(Figs. 26 and 27). The links have a hook on one end which slips over the end of the next link, and so on until the chain is completed. When such a hook chain is used, no matter whether it is steel or malleable iron, *the hook should run with the open part away from the sprocket wheel and leading in the direction of travel*, as shown in Figs. 26 and 34. Chain belting should be run fairly loose. Undue tightness simply wastes the power and cuts down the life of the chain. Some form of chain tightner should be used with all chain belts. These tightners may be either a slide, a smooth wheel, or a sprocket wheel. They may be either fixed or held against the chain by a spring.

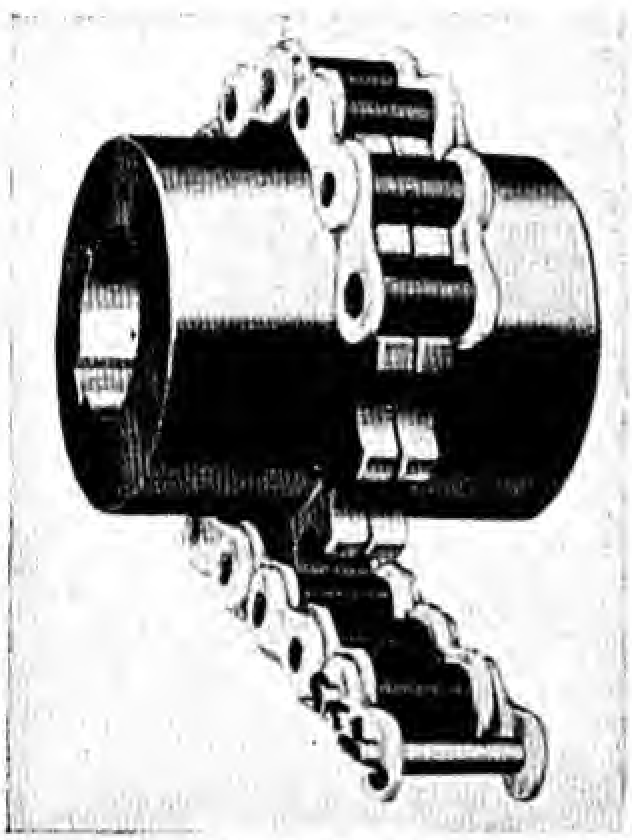


Fig. 32.—Flexible coupling using roller chain to connect the coupling halves.

57. Transmission of Power by Gears.—Where the machine is rather compact and the shafts are close together,

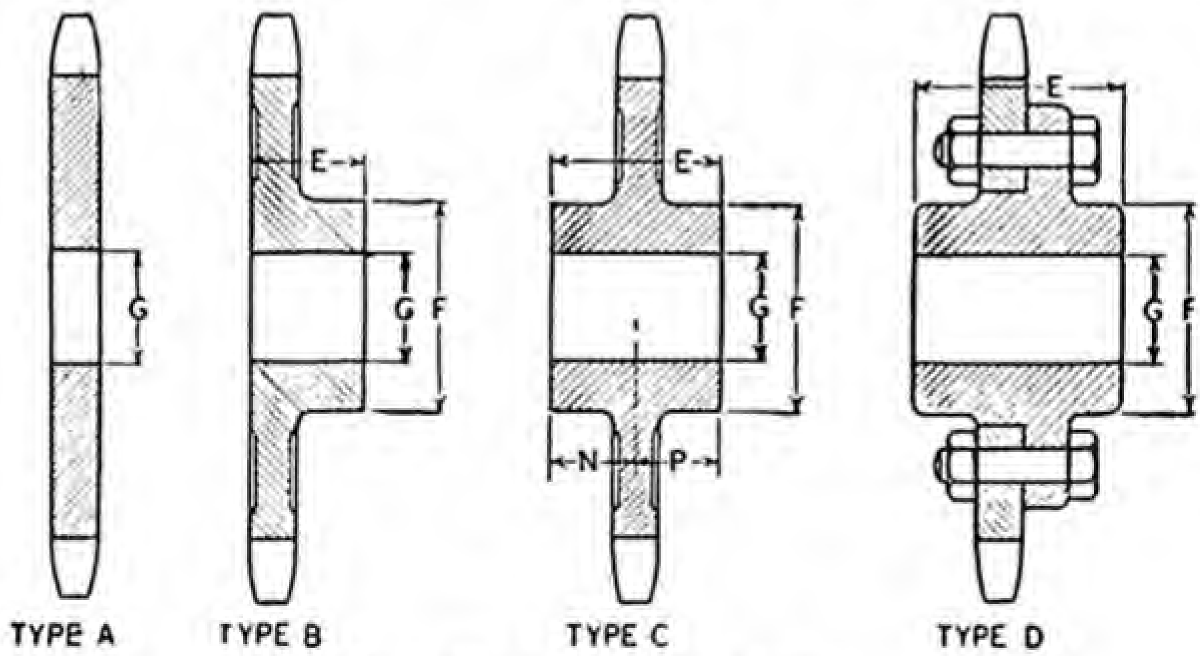


Fig. 33.—Sprocket types.

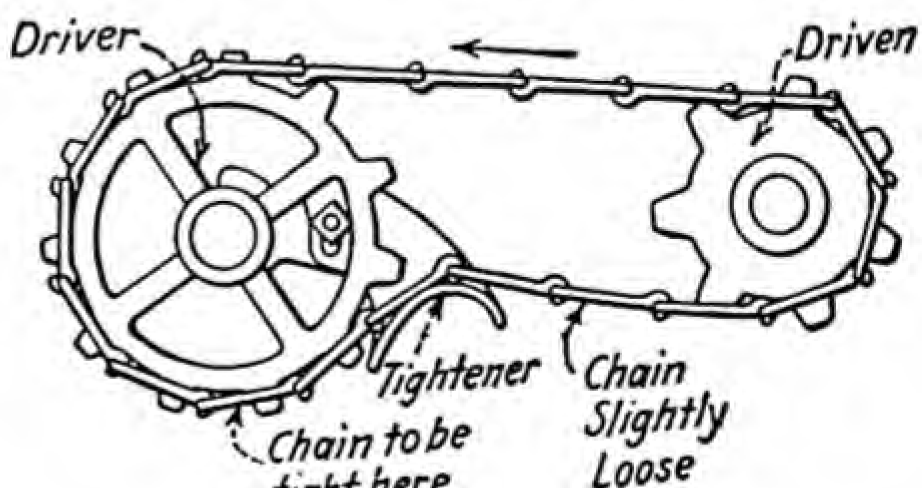


Fig. 34.—The proper method of running a hook chain on the sprockets.

gears may be employed to transmit the power, as shown in Fig. 35. The type of gear may be either spur, bevel, worm, bell, or helical.

Often there is a combination of either spur or bevel or other type. If the power is transmitted parallel to the shaft, helical, bell, or spur gears are employed; but if the shafts are at right angles, the bevel or worm gear must be employed. The use of gears makes a more substantial construction and eliminates a great amount of lost motion; however, the cost is greater, especially in the case of repairs. It is much cheaper to replace one or two links in a chain than to replace a complete gear. When one tooth is broken and all the others remain, the gear cannot be used.

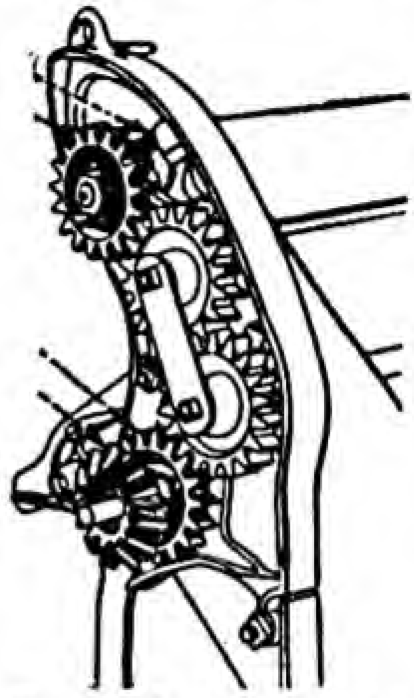


Fig. 35.—Transmission of power by gears.

58. Kinds of Gears.—*Spur gears* have their shafts parallel. The teeth that make up the gear have their surfaces parallel to the shaft. In an *internal* spur gear (Fig. 36), the teeth are on the inside of the rim. An *external* spur gear (Fig. 37) has teeth on the outside of the rim. With every internal spur gear it is necessary to have an external spur gear to operate it; but if there are two external gears, they may be used together without the use of an internal spur gear. Figure 38 shows a rack and pinion.

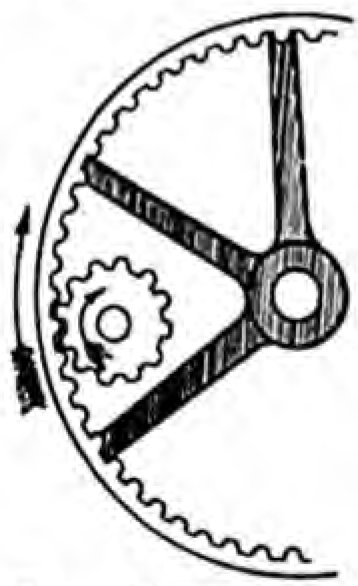


Fig. 36.—Internal spur gear.

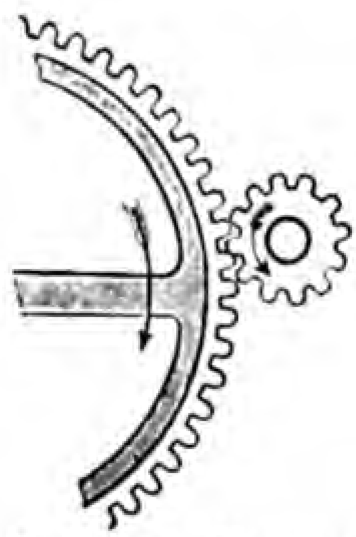


Fig. 37.—External spur gear.

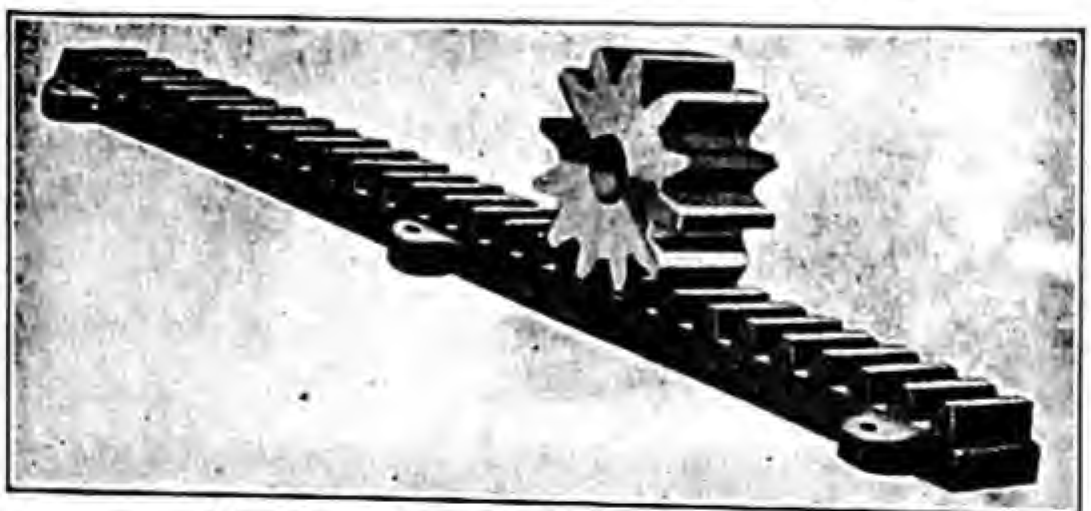


Fig. 38.—Rack-and-pinion spur gear.

A *pinion* is the smaller gear of any two gears that are meshing together; it may be a spur, bevel, or helical gear.

FIG. 39.—Bevel gear and pinion.

Beveled gears (Fig. 39) have their shafts at right angles or nearly so. Where the power has to turn a corner, beveled gears are used. The teeth are at an incline varying according to the difference in diameter of the gears meshing together. Beveled gears tend to wear so that their teeth do not fit one another closely, and for this reason there should always be some method of adjustment. Miter gears have an equal number of teeth cut at the same angle (Fig. 40).

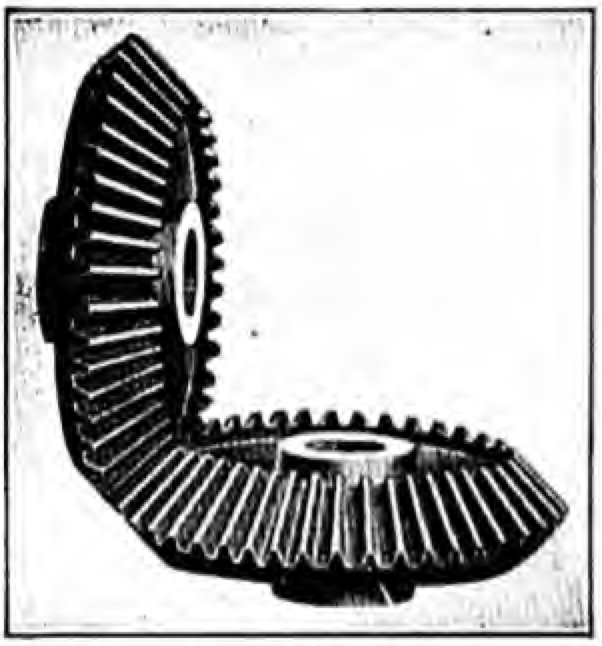


FIG. 40.—Miter gears.

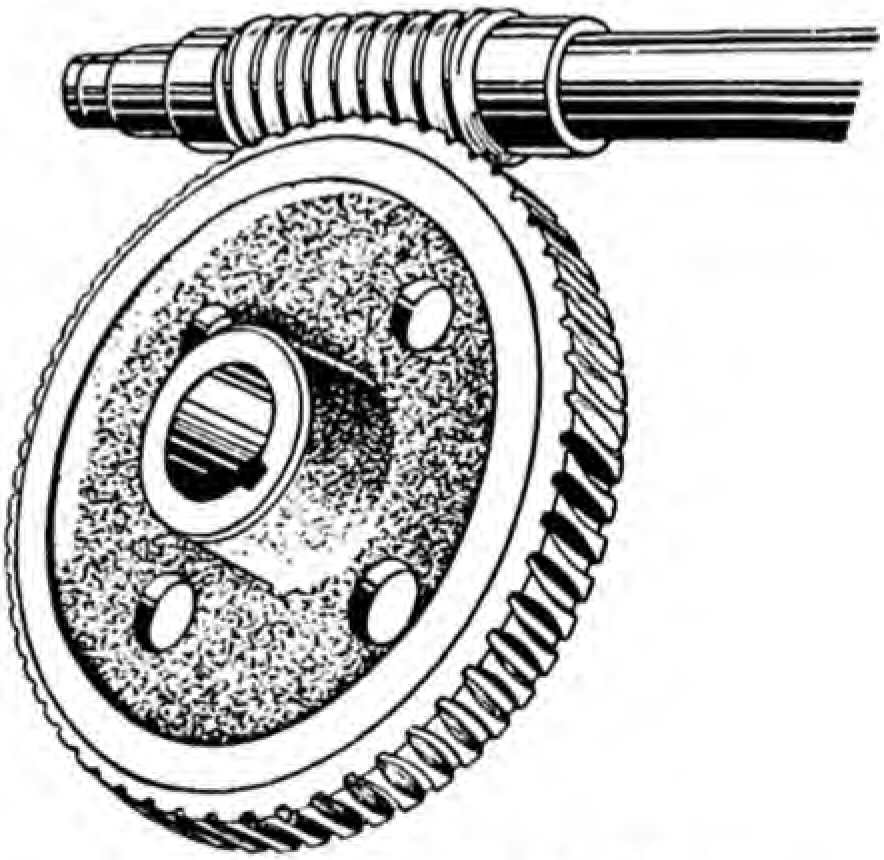


FIG. 41.—Worm and gear.

Worm gears (Fig. 41) consist of a shaft, called the *worm*, with screwlike threads which run spirally around it. This meshes with a helical spur gear called the *sector*. As the worm turns, the teeth of the sector, which fit in the grooves, are turned around slowly. This type of gear is used to a limited extent in farm machinery.

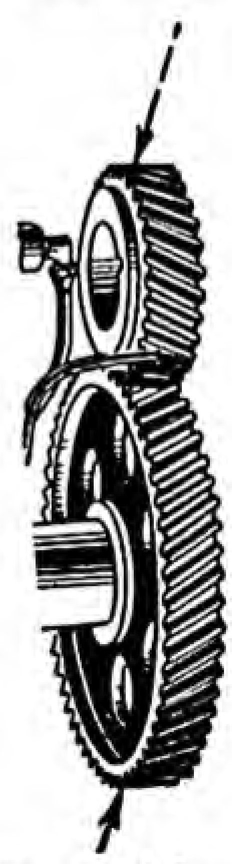


FIG. 42.—Helical gears.

Helical gears (Fig. 42) may take the form of either spur gears or beveled gears, but they do not have straight teeth. The teeth are more or less curved so that they will remain in mesh or in contact longer than straight teeth. In the spur gear they are called *helical spur gear;* in the beveled type they are called *helical beveled gear*. When helical gears are used much noise is eliminated, because of the fact that the teeth remain in contact longer, giving an even, constant pressure at all times.

59. Transmission of Power by Triangles.—It is often desirable to transmit power some distance from the point

where it is generated, as in the case of operating a pump by a windmill which is not over the well. The method used to handle this situation is to have a crossarm or rocker arm at both the source of power and the point to which it is distributed. At each end of the crossarm a wire is attached extending to the opposite end of the other crossarm, causing the two wires to cross about halfway between, as shown in Fig. 43. The

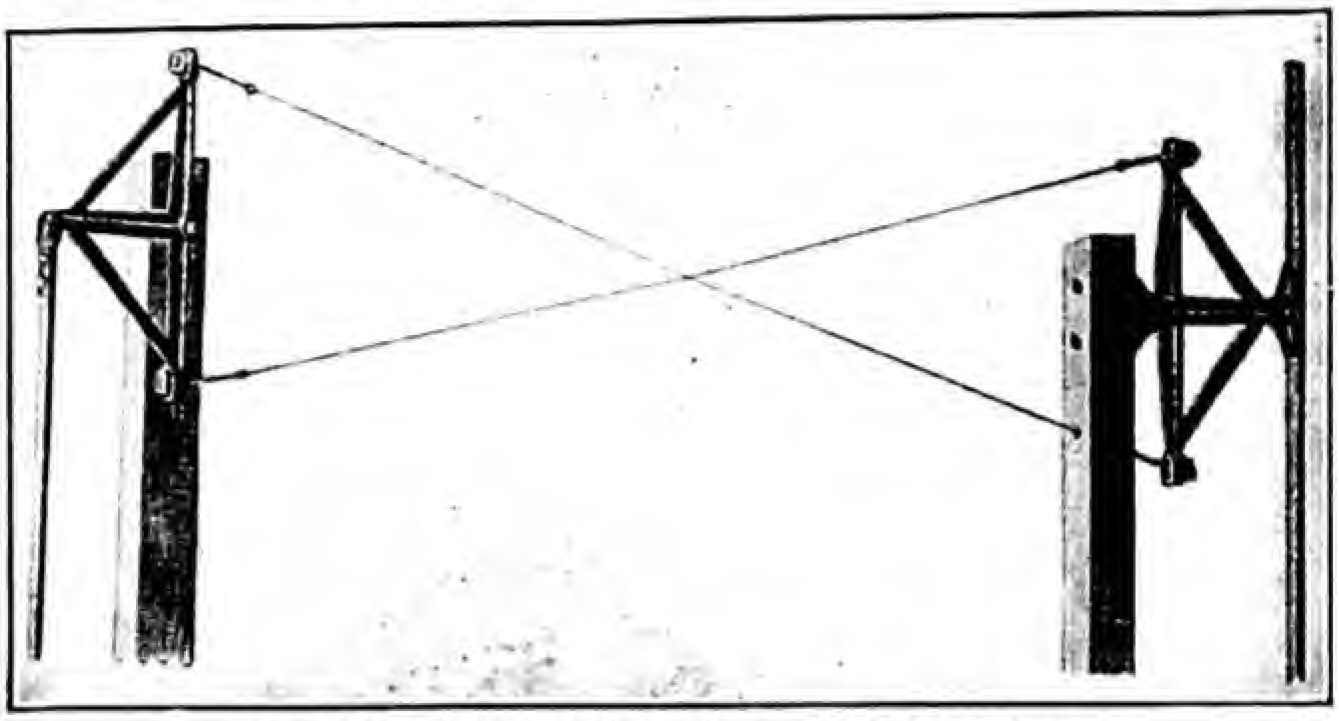


FIG. 43.—Transmission of power by triangles.

lifting stroke of the pump comes at the same time the pull comes at the windmill and thus prevents buckling of the parts. If power is transmitted from a gas engine, it is not necessary that the wires be crossed. By the use of triangles, a series of pumps may be operated by one engine.

60. Universal Joints.—Where machines are operated from the power-take-off of tractors, universal joints are installed on the power shaft to permit the machine to be adjusted and to turn corners. A telescoping section (Fig. 44) is usually placed between two universal joints, as the distance between the tractor and the machine varies when turning and moving over uneven ground.

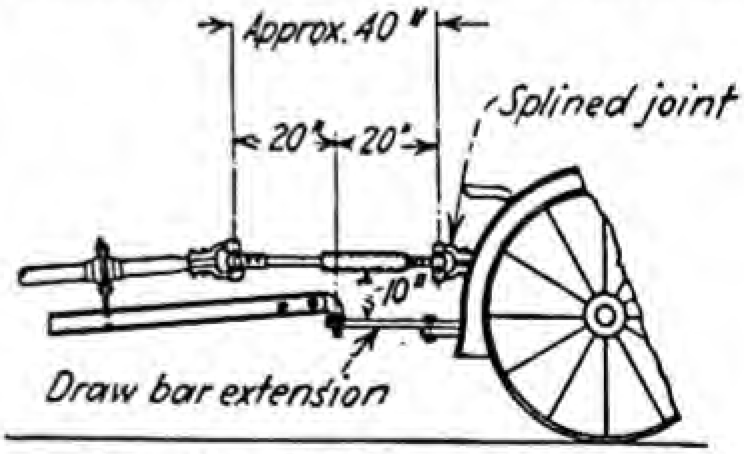


FIG. 44.—Double universal joint used on the power-take-off to operate a tractor grain binder.

61. Electrical Transmission of Power.—In many parts of the country electrical companies have made electrical power available to rural districts. In such cases the electricity is generated at some central source and transmitted over wires to the various farmsteads where it is used for lighting purposes and for running electrical motors to accomplish many types of work. Where the farmer owns his own individual light plant, it will be found that electricity can be used to an advantage to furnish not only light but power as well for small jobs around the farm home.

62. Bearings.—In all farm machinery, bearings of various types are used. The proper bearing to use is determined by the amount of wear, the speed at which the shaft is turning, the load it must carry, and the amount of end thrust. One type of bearing may give better service under certain conditions than another. Bearings are divided into the following types: solid, plain or split, ball, roller, and self-aligning.

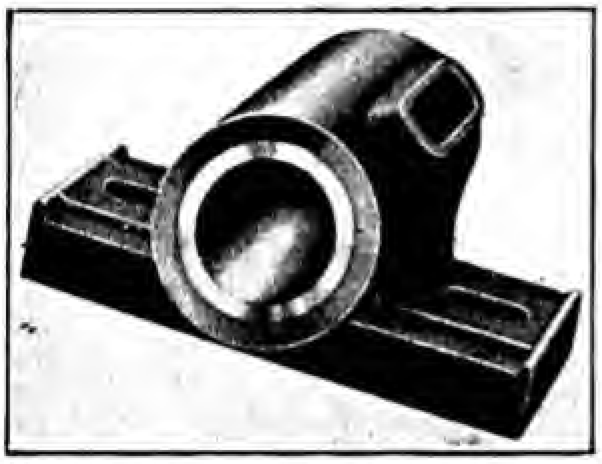


Fig. 45.—Solid bearing.

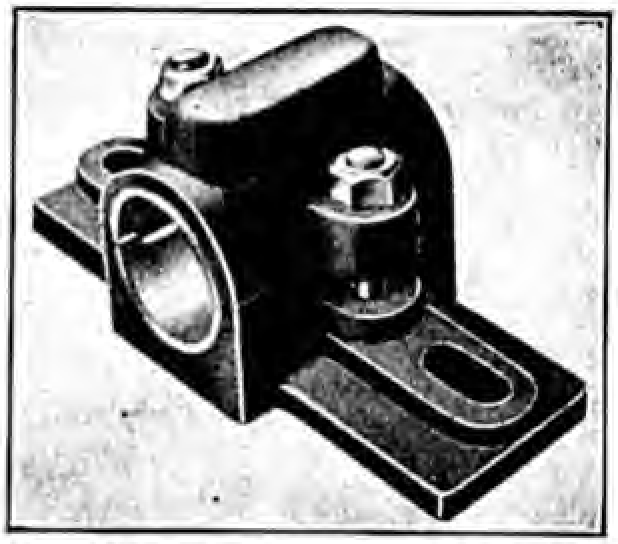


Fig. 46.—Plain or split bearing.

The simplest type of bearing is known as the *solid bearing* and is shown in Fig. 45. It consists of a piece of wood or cast iron with a hole bored through it large enough for a revolving shaft. Some of the better types are provided with bushings which can be removed and replaced. They are nonadjustable. The pitmans of grain binders have solid bearings.

When the bearing is cut into two parts, as in Fig. 46, either horizontally or at an incline, and the upper part is bolted to the lower part, it is called a *cap* or *split bearing.* The upper part can be removed and the shaft lifted out of the bearing.

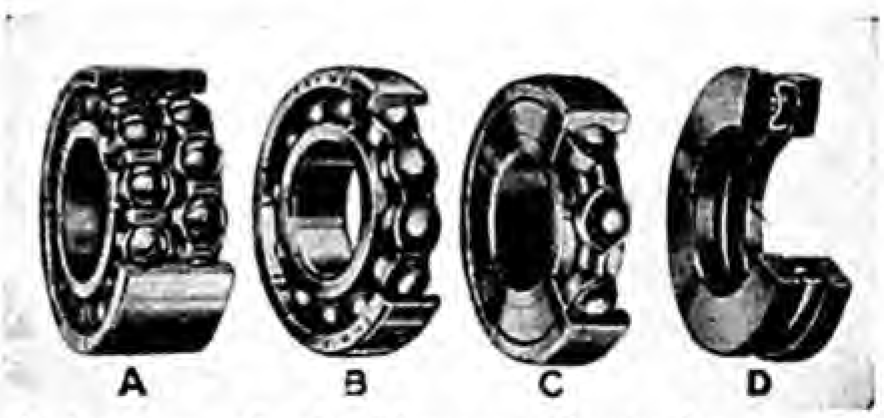


Fig. 47.—Types of ball bearing: *A*, double-row; *B*, single-row; *C*, single-row, with ring seal; *D*, end-thrust.

Ball bearings are bearings having one or more rows of small balls placed in a cage or holder. The balls are separated slightly and held in position by a retainer. Because of the small amount of surface in contact between the balls and the shaft, friction is reduced to a very low point. Figure 47 shows ball bearings to take radial loads and end thrust. Formerly, ball bearings were only used in farm machinery to take up the end thrust, but now they are also being used for main bearings on the

cylinders of threshing machines, the main shafts of feed mills, and many other points.

Roller bearings differ from ball bearings in that small cylindrical rollers are substituted for the balls. This gives a much longer bearing surface,

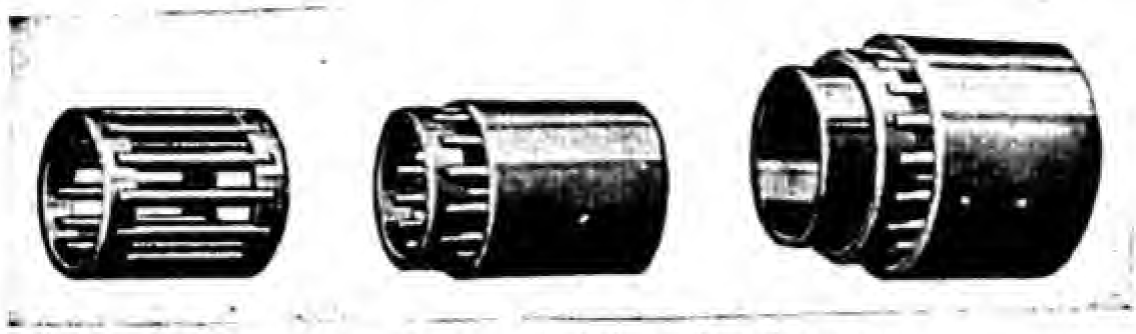


FIG. 48.—Parts of plain roller bearing.

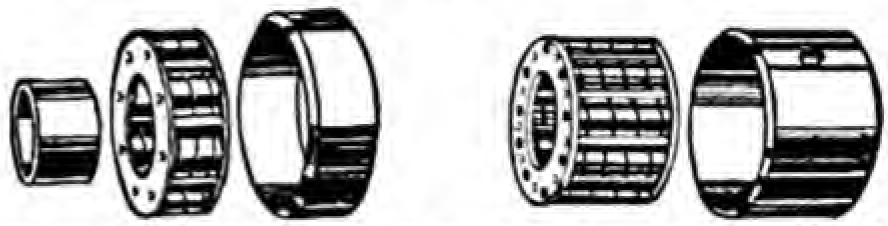


FIG. 49.—The various parts of two applications of Hyatt roller bearings.

FIG. 50.—Application of Timkin taper roller bearing.

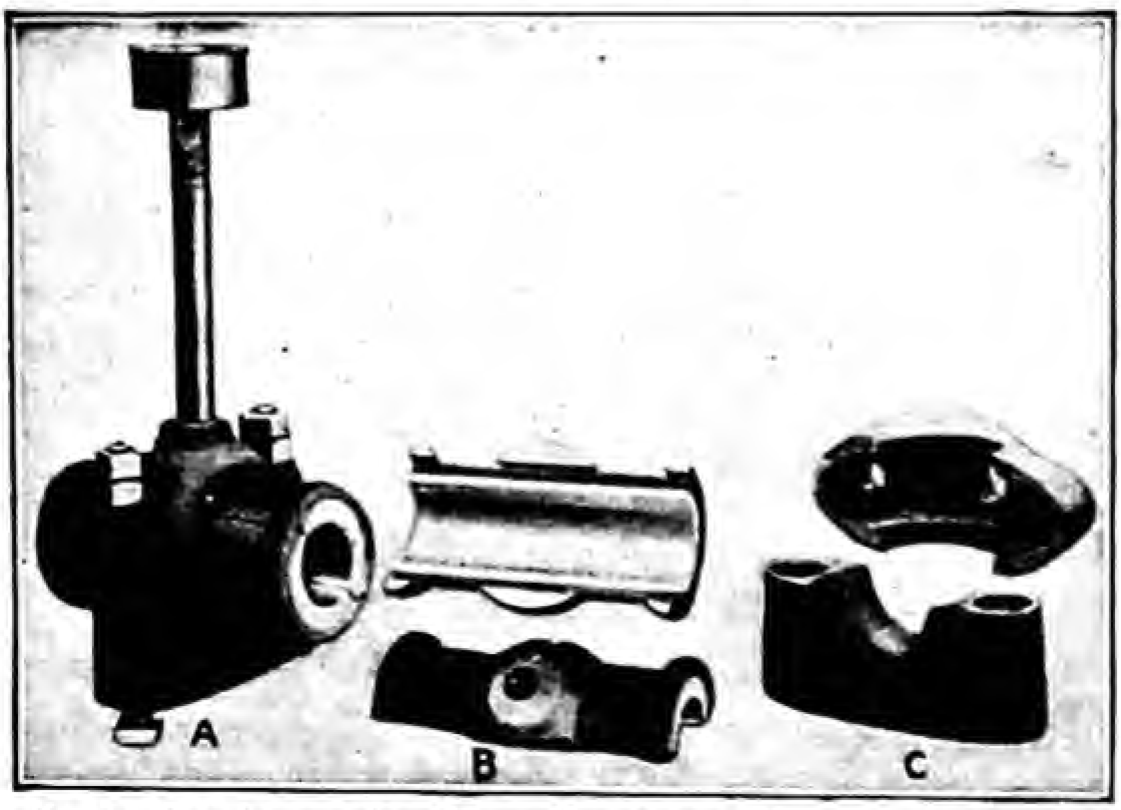


FIG. 51.—Self-aligning bearing: *A*, bearing assembled; *B*, inner unit; C, outer shell or socket.

such as is necessary for a heavy load. There are also cages to hold the rollers apart as in the ball bearings. Figures 48 and 49 illustrate several types of roller bearings. Figure 50 shows the various parts of a taper roller bearing. This type is used largely on the heavy farm machines.

The construction of the *self-aligning bearing* (Fig. 51) calls for two

separate units. The bearing proper, the part with which the shaft is in contact, and the shell or frame, in which it is held, make up the two units, commonly called the *ball and socket.* The socket or shell C is often divided into two parts, the lower and the upper, and is hollowed out on the inside to conform to the ball-shaped cast around the outside of the bearing proper at its middle. When in position the bearing unit is held securely in place, but because of the ball-and-socket construction, the bearing has a limited movement within the shell, which permits it to align itself with the shaft if it should become twisted in the frame. Such an arrangement practically eliminates any tendency of the bearing to heat because of misalignment. If improperly adjusted, however, the swiveling action may be retarded and heating take place.

63. Heating of Bearings.—Much loss of time often results from bearings becoming overheated, in some cases so hot that the soft metallic lining melts and a burnt-out bearing results. Some common causes of bearings heating are lack of oil, cap too tight, belt too tight, and the collar on the shaft too close against the bearing.

64. Bushings.—A *bushing* is the lining of a bearing. It may consist of bronze, babbitt, or wood.

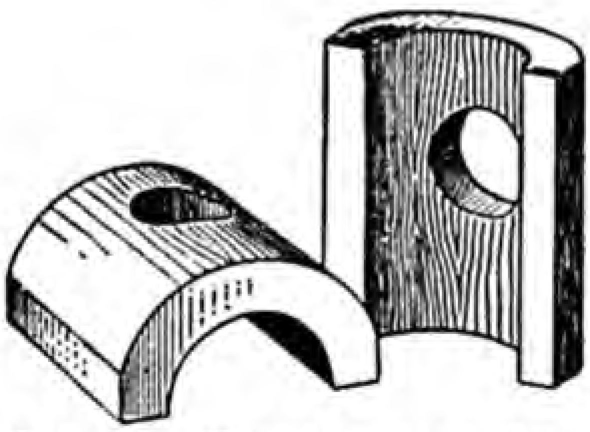


Fig. 52.—Wood bushings for bearings.

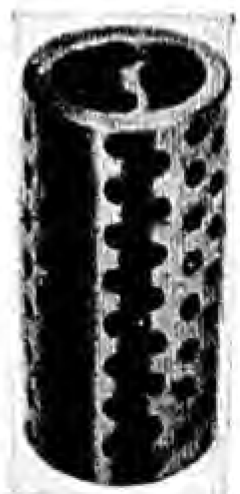


Fig. 53.—Oilless bushing.

Wood, being a cheap material, is often used to line bearings where they are subjected to a considerable amount of sand and dust, which cause rapid wear. Bearings on disk harrows (Fig. 52), in the majority of cases, are lined with wooden bushings. This allows frequent replacing of the bushings with small expense. Wooden bushings are usually made of maple which has been hardened by boiling in oil.

Bronze is an alloy containing about 80 per cent copper and 20 per cent tin. This metal gives a good, hard, wearing surface and is used extensively in bearings on farm machinery where the speed is rather high and the load heavy and heating likely to occur, such as the pitman box of the mowing machine and bearings for each end of the pitman shaft. This

metal makes a very lasting bushing, wearing rather slowly if proper care is taken of the bearing by oiling it frequently and keeping everything tight.

Babbitt is an alloy of tin, copper, and antimony. This metal is also used to some extent in lining bearings on farm machinery. Babbitt can be easily melted and poured into a bearing. It is a rather soft metal but at the same time resists a great amount of wear. It must be well lubricated at all times or it will heat and melt.

65. Babbitting a Bearing.—First clean out the bearing; remove all old metal, grease, and dirt. Set the bearing on some solid place and level it. If the bearing is a plain one, wrap a piece of writing paper around the shaft; place the shaft in the center of the bearing and align it. If the paper is not placed around the shaft there will be difficulty in removing it from the bearing after the molten metal has been poured around it. If the bearing has a cap, place shims between the cap and the base. At the end of the bearing, place some clay, putty, or soap tightly around the bearing and the shaft to hold it in the babbitt. Care should be taken to see that no water gets into the bearing proper. If some water should happen to be in the bearing when the babbitt is poured in, steam will form and the babbitt will be blown out. This hot babbitt can give a person a bad burn.

66. Clutches.—In most of the larger machines for the farm, special arrangements must be made to disengage the power from the various working parts of the machinery, such as in mowers when moving from one field to another. It is not advisable nor is it practical to keep the cutting mechanism in constant motion; therefore, a clutch is arranged so that the drive wheel is allowed to turn without driving the cutting mechanism. There are two different types of clutches in use on farm machinery, namely, friction and positive.

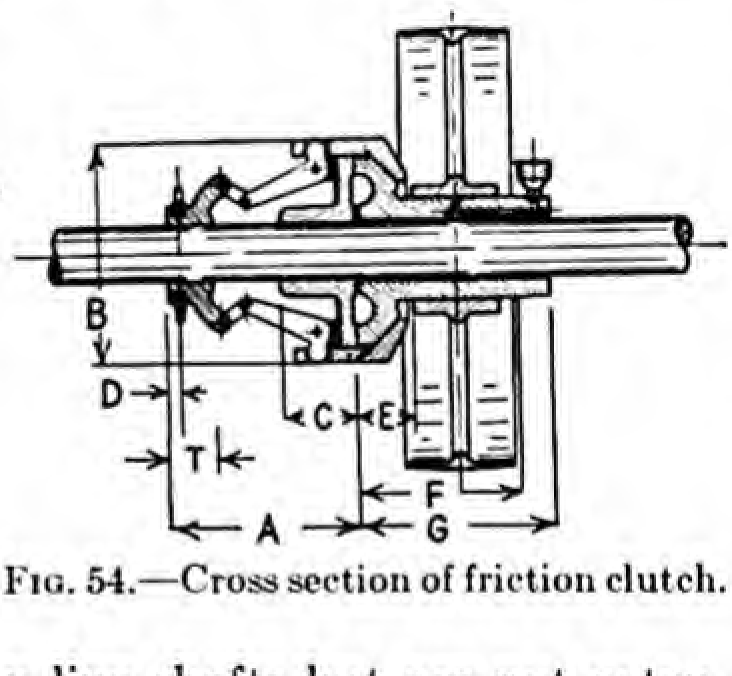


FIG. 54.—Cross section of friction clutch.

Friction clutches (Fig. 54) are used on line shafts but are not extensively used on field machines because of the rapid wear. They consist of two parts pressed together to such an extent that one will not slip upon the other. Both turn as a unit.

The *positive clutch* (Figs. 55 and 56) is the one used practically altogether on farm machinery. It consists of two parts which have teeth so placed that when they are brought together they engage instantly and allow no slipping. This type of clutch has the disadvantage of causing the various mechanisms of the machine to start instantly at a high rate of

speed when the clutch is engaged. This causes quite a bit of strain on the various parts and may often cause breakage. The load cannot be eased on, as it can be with the friction clutch, which allows the machinery to start slowly and finally come up to the required speed.

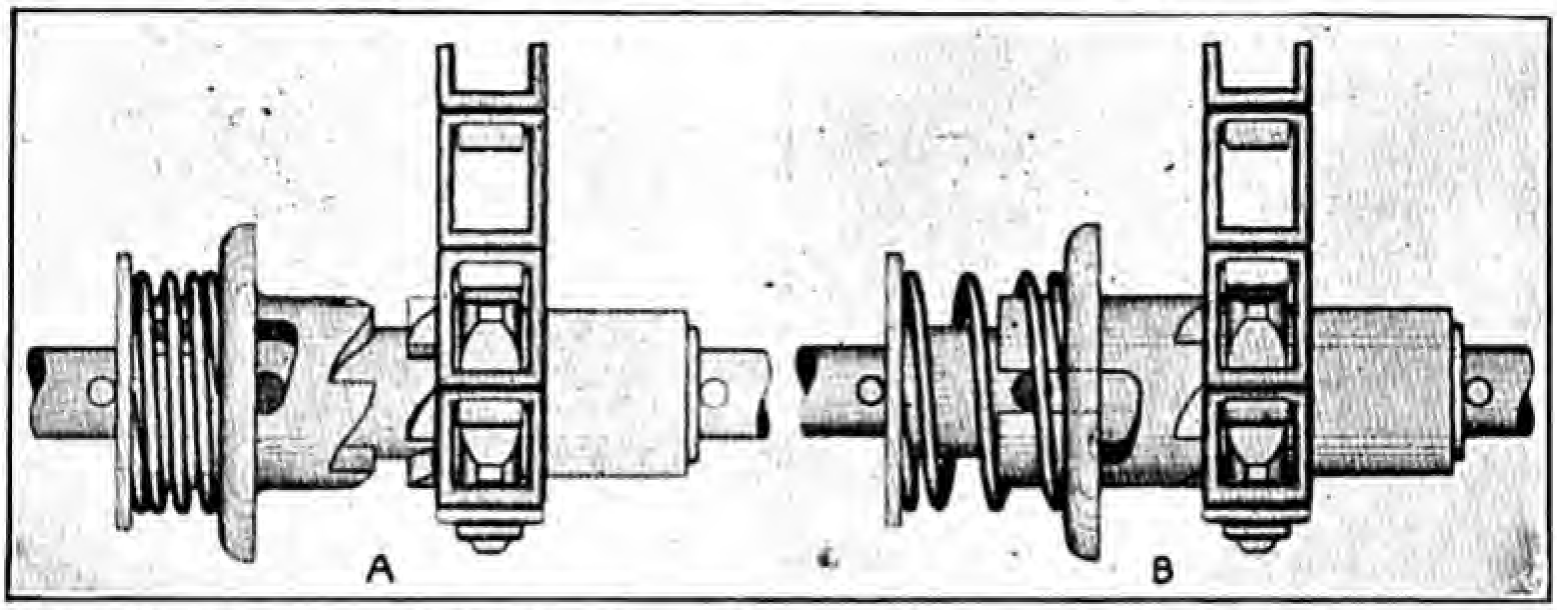


FIG. 55.—Positive type of clutch: *A*, clutch parts disengaged; *B*, clutch parts engaged to transmit power.

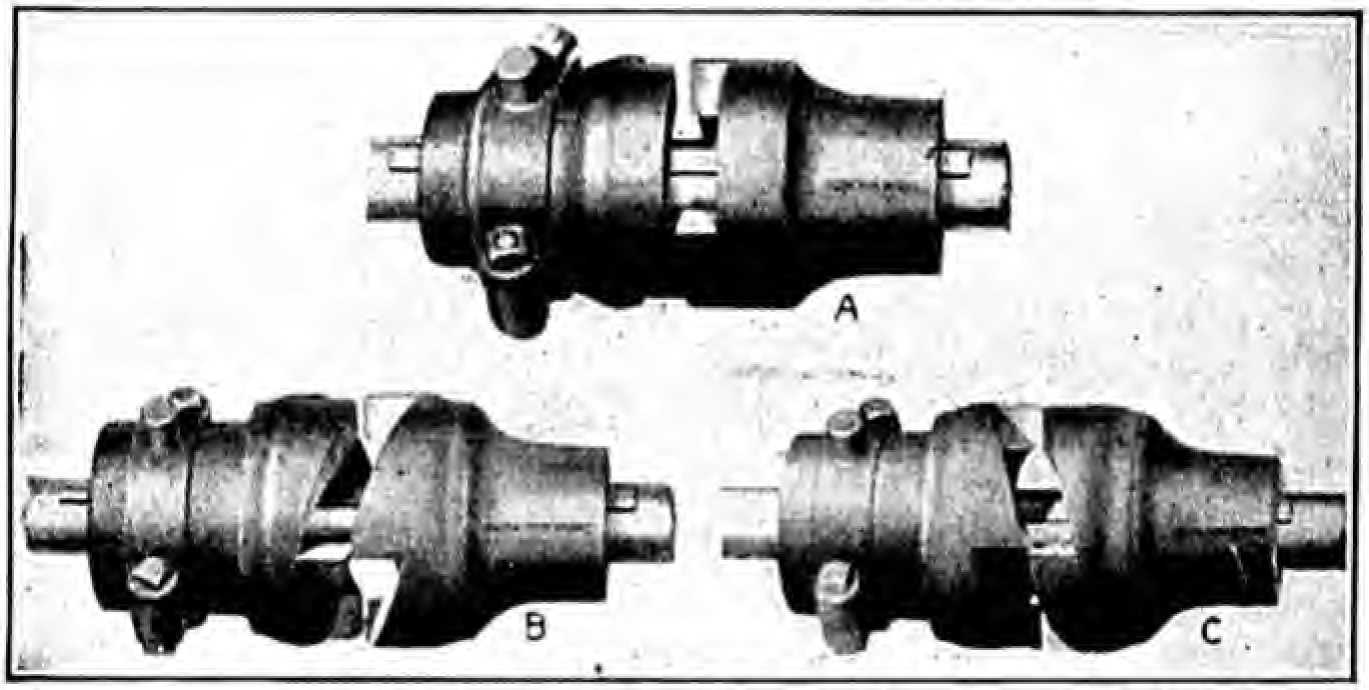


FIG. 56.—Types of positive clutch: *A*, square-jaw clutch coupling; *B*, left-hand spiral-jaw clutch; *C*, right-hand spiral-jaw clutch.

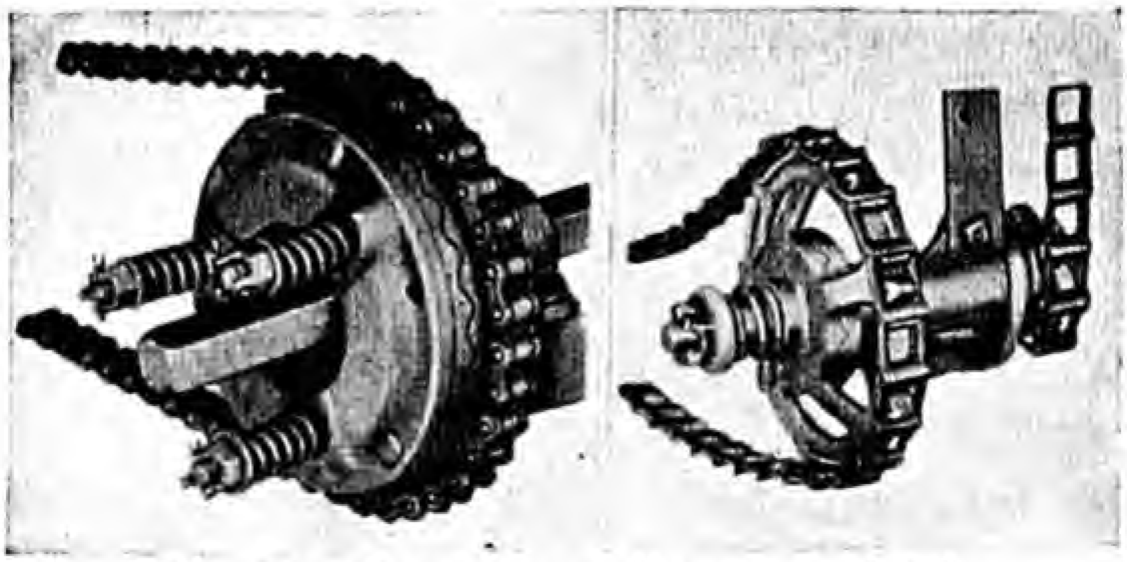


FIG. 57.—Two types of slip or snap clutch.

Figure 57 shows a type of safety clutch that is being used on power-take-off machines. It is also used on bundle carriers for binders.

67. Cam.—A *cam* (Fig. 58) is a device that produces intermittent motion. When an object is in motion part of the time and at rest between

motions, the action is said to be *intermittent*. A cam may best be described as a wheel with a hump or nose on one side (Fig. 58). The part of the cam that projects is called the *nose*. Anything resting against the cam will be moved only when the nose comes around to it; otherwise, it remains stationary. The arrangement shown on the left in Fig. 59 is used in power-lifting devices for plows, for agitators, and for ratchet drives, such as the operation of the apron of the manure spreader. It is called an *eccentric drive* when used to operate in both directions.

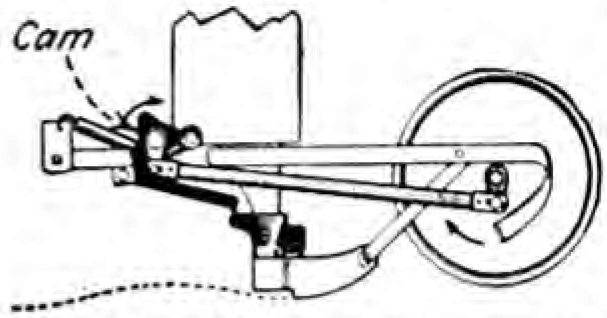


FIG. 58.—Cam used to operate furrow opener of planter.

68. Ratchet and Pawl.—A *ratchet* consists of gearlike teeth (Fig. 59) placed in the form of either an internal or external spur gear. These

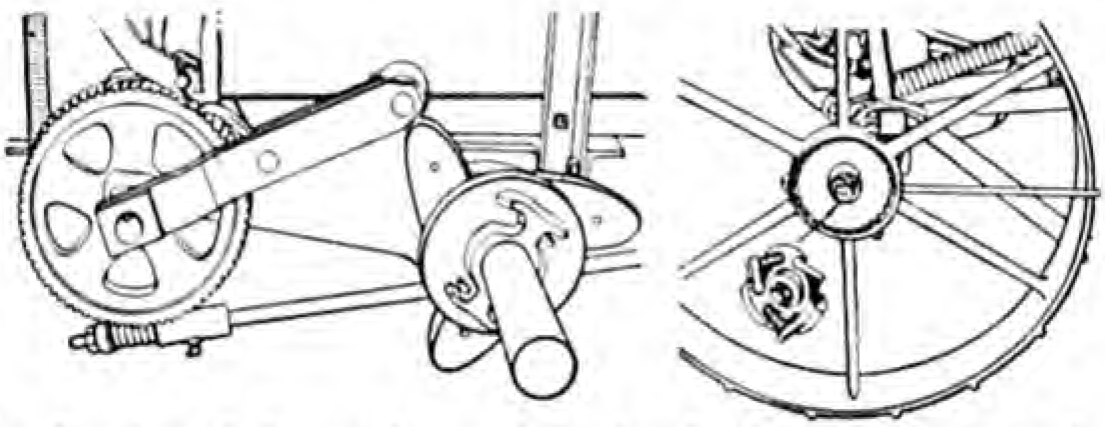


FIG. 59.—Application of the ratchet and pawl. *Left*, pawls are moved on the ratchet, by a three-lobed cam. *Right*, pawls fastened to the axle of a mower catch the ratchets in the wheel hub.

teeth generally have an equal slope from the vertex of the teeth on each side, or they may take the form of a hook. The small pieces of cast iron or steel that engage the teeth of the ratchet are known as *pawls*. The

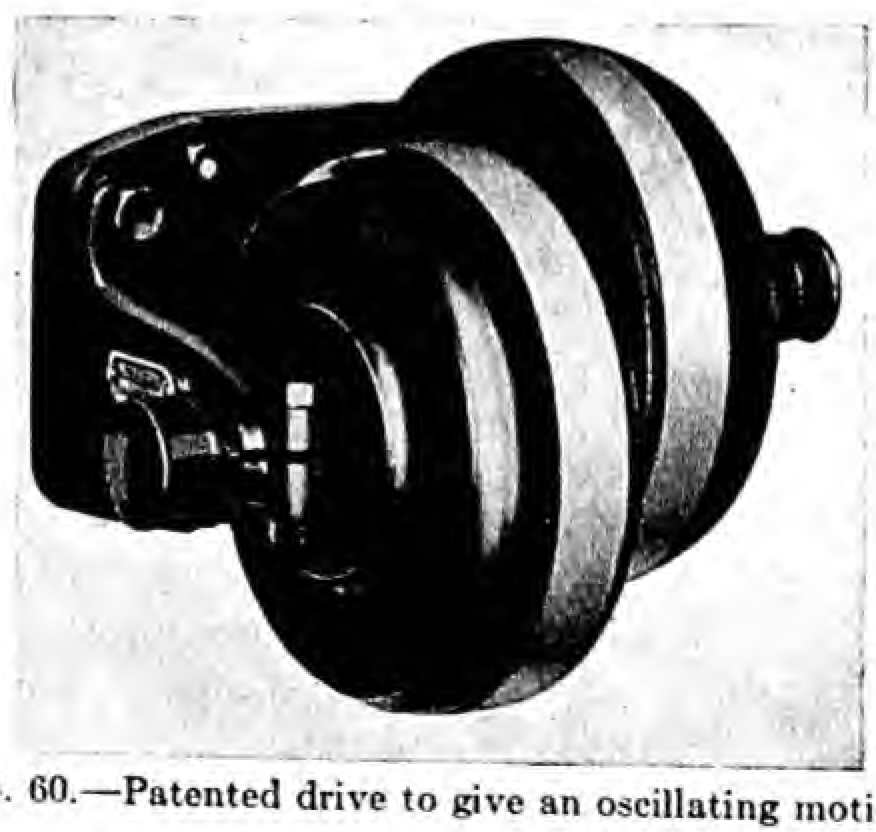


FIG. 60.—Patented drive to give an oscillating motion.

ratchets are always placed in such a manner that when the pawls, which are attached to the shaft by means of a pawl plate, mesh with the ratchet

teeth, a force is exerted on the shaft causing the two to turn as a unit. If the ratchet is turning in the opposite direction, the shaft does not turn because the pawls slip over the teeth. The ratchet may be so designed to give power to the pawl or *vice versa.* Such arrangements are used where motion in one direction and none in the other is wanted, for example the wheels for mowers, manure spreaders, and grain drills.

69. Keys.—Keys are of two kinds: first, those that fit into a slot in both the shaft and pulley, holding the two firmly together and causing them to turn as a unit; second, the cotter or split keys that are put through a hole in the end of a bolt or pin to hold the nut and washer on.

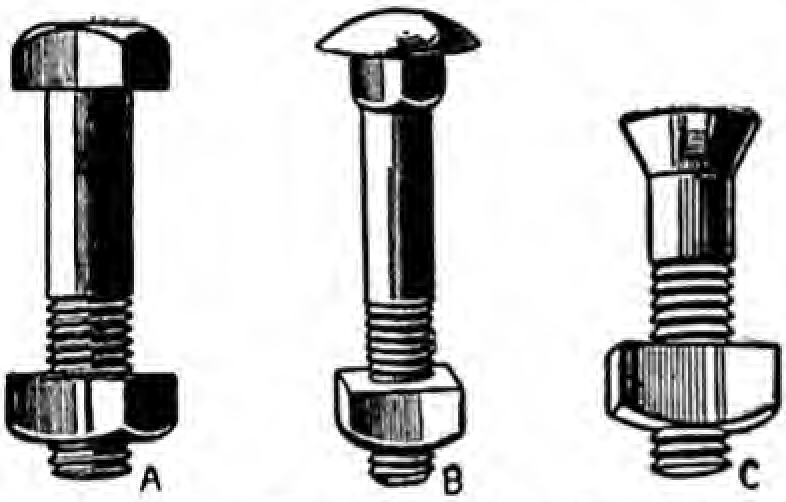


FIG. 61.—Types of bolt: *A*, machine bolt with nut; *B*, carriage bolt with nut; *C*, plow bolt with nut.

70. Bolts.—The great variety of bolts used in the construction of farm machinery may be classified as follows: machine, carriage, stove, and plow bolts.

Machine bolts are used for holding two pieces of metal together. They have a square or hexagonal head with the stem of the bolt fitting into the head without any change of diameter, as *A* Fig. 61.

Carriage bolts (*B* Fig. 61), unlike machine bolts, have a rounded or oval-surfaced head having a square shoulder underneath extending out some half an inch, varying according to the size of the bolt.

Plow bolts may have many different kinds of heads, but practically all of them have from one to four shoulder-like points that fit into a groove prepared for them in whatever material they are placed. The undersides

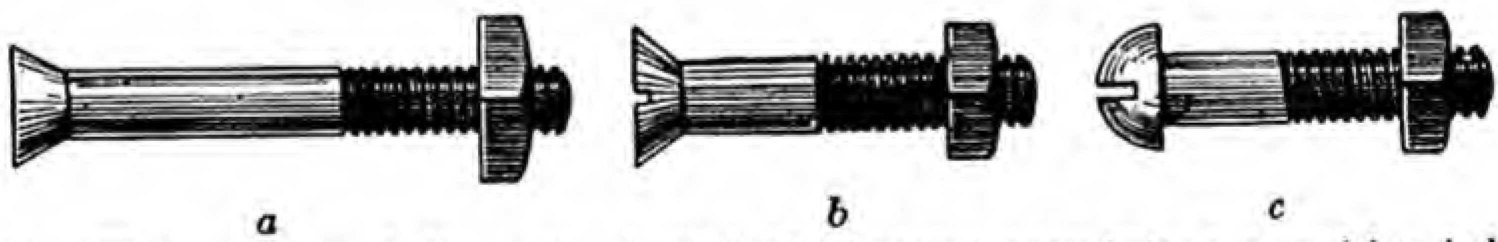


FIG. 62.—Tire and stove bolts: *a*, tire bolt; *b*, flat-headed stove bolt; *c*, round-headed stove bolt.

of the heads of plow bolts are always countersunk (*C* Fig. 61), so that the head may go deep enough into the material that it will fit flush with the surface. Such bolts are used for holding plowshares.

Stove bolts, as shown in Fig. 62, are rather short bolts having threads running down close to the head, which may be either flat or round. Most stove bolts also have a slot cut across the heads so that screw drivers may be used to prevent them from turning. This type of bolt is used for bolting thin metal together.

Tire bolts (Fig. 62) are used to hold wagon and carriage tires on the felloe of the wheel.

71. Nuts.—The most common types of nuts used on farm machinery are shown in Fig. 63. The square nut is used on the cheaper machines, but the hexagon nut is used on the higher class machines. Castellated nuts are used where vibration is likely to cause the nut to work loose. Wing nuts are used where it is necessary to remove a part frequently. Lock nuts are constructed so that they automatically lock themselves in place.

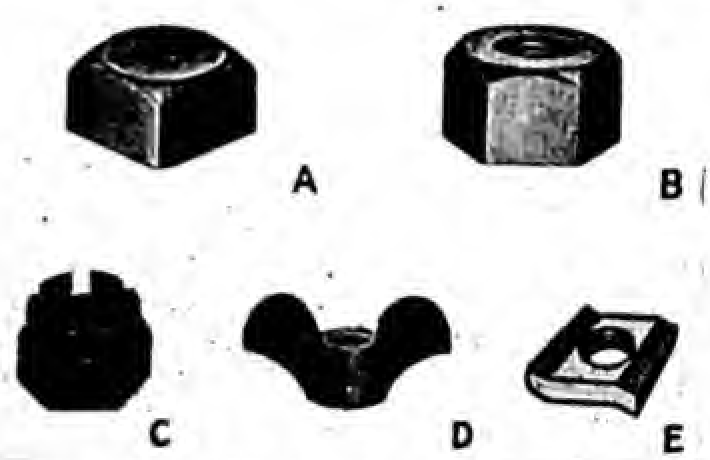


FIG. 63.—Nuts: *A*, square nut; *B*, hexagon nut; *C*, castellated nut; *D*, wing or thumb nut; *E*, square lock nut.

72. Screws.—Many types of screws are also used in the construction of farm machinery. They may be classified as follows: set, cap, lag, and wood.

Setscrews (Fig. 64) may have several different shapes for the point. They are so called because they extend through the collar, allowing the point to come in contact with the shaft so that the collar and shaft will be fastened rigidly together and turn as a unit. They are also used in the same way to prevent various parts from moving out of place.

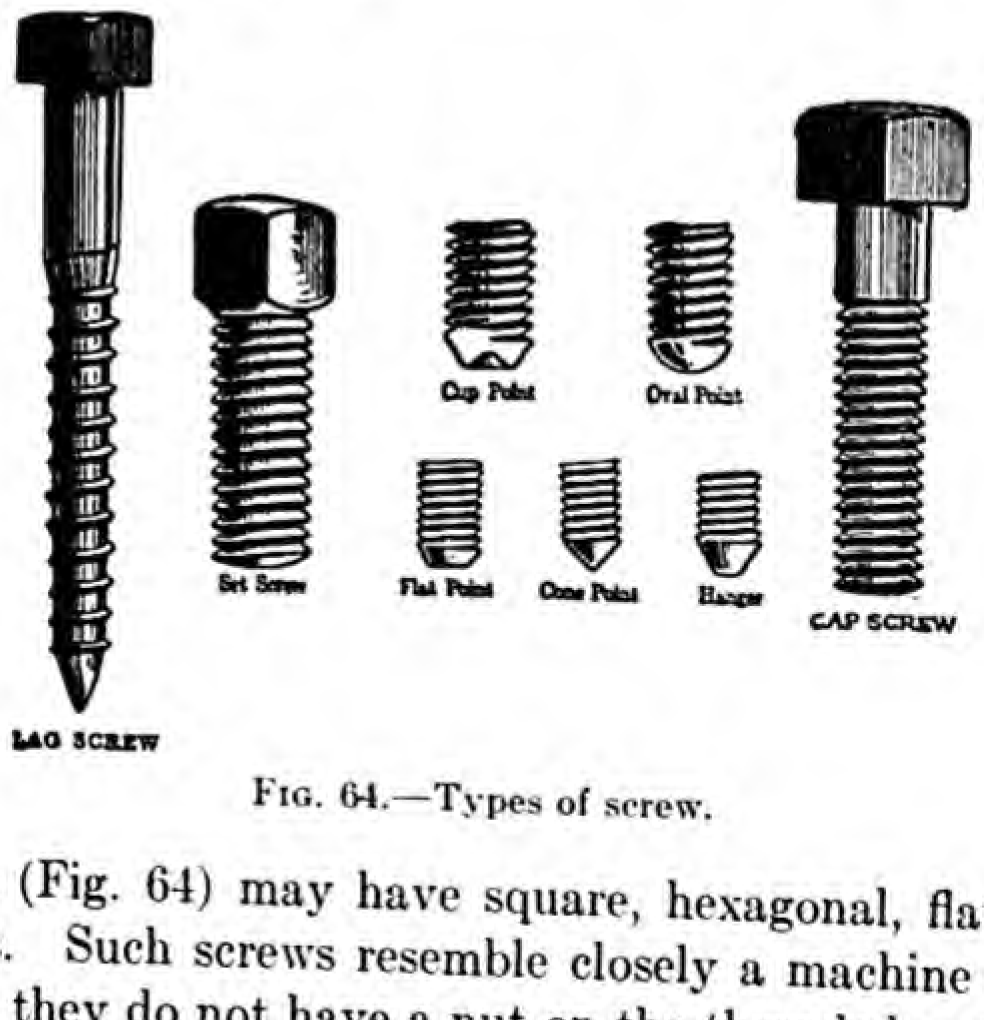


FIG. 64.—Types of screw.

Cap screws (Fig. 64) may have square, hexagonal, flat, and button types of heads. Such screws resemble closely a machine bolt with the exception that they do not have a nut on the threaded end; instead, the end passes through whatever it is to hold into a threaded hole which serves as a nut, for example, the cylinder head of an automobile.

Lag screws (Fig. 64) have heads like a machine bolt, while the other

end is sharp. The threads are coarse and similar to an ordinary wood screw. They are used to attach machinery to floors or beams. The coarse threads, when started, will draw themselves into the wood as the screw is turned with a wrench.

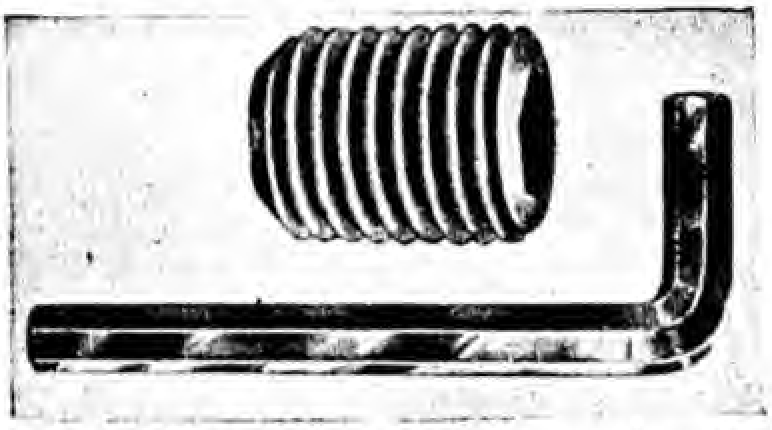


FIG. 65.—Hollow-head setscrew and wrench.

Wood screws, unlike lag screws, are rather small and have slots across the head so that a screw driver can be used to force them into the wood.

73. Washers.—Different kinds of washers are used extensively in connection with bolts in farm machinery. They may be used on either

(a) (b) (c)

FIG. 66.—Machine screws: *a*, round head; *b*, flat head; *c*, fillister head.

the end beneath the head of the bolt or beneath the nut. Washers are of various kinds as follows: flat malleable-iron, cast-iron, wrought-iron, and spring-lock washers. There is very little difference between malleable- and cast-iron washers, both being rather thick, oftentimes ½

A B

FIG. 67.—Quick-repair washers: *A*, side latch; *B*, over latch.

inch, and placed where there is a considerable amount of wear. Wrought-iron washers are round discs with holes in the center to allow their being placed under the nut. Lock washers (Fig. 67) are made of spring steel with one side split from edge to center of the hole. The ends of the split

parts are turned in such a manner that they will allow a nut to be turned down easily but resist any effort to turn it off.

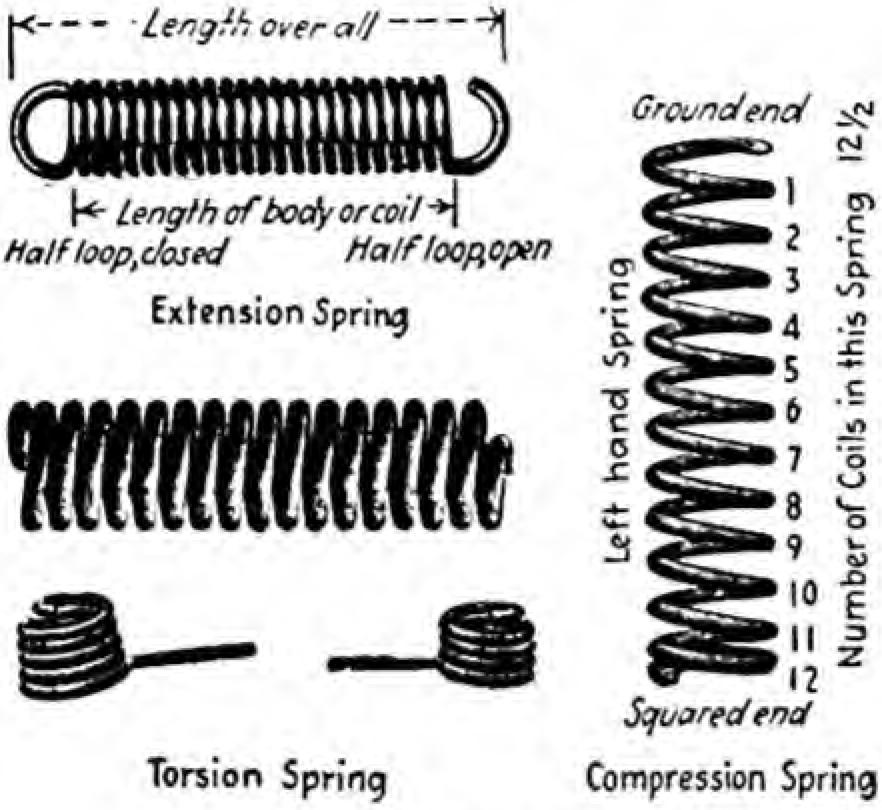


Fig. 68.—Springs.

74. Springs.—Springs (Fig. 68) play an important part in the operation of farm machinery. Extension springs aid in lifting and adjusting heavy implements. Compression and torsion springs facilitate the operation of certain parts of a machine.

CHAPTER VI

SELECTION OF FARM MACHINERY

Before taking up the general discussion of the various individual farm implements and their construction features, it is well to stop and consider some important items that apply to all implements in general. These points or qualities that a machine may have or lack are abstract in a way, yet fundamental in their bearing on the quality of the machine. They are factors that will enable the student to judge a machine better; they will call to his attention the points to look for which may have an important influence on selecting one machine over another.

75. Trade-mark.—The standard definition of a *trade-mark* is as follows: Trade-mark is a distinguishing mark, device, or symbol fixed by a manufacturer, merchant, or trader to his goods in order to identify them as his goods and to distinguish them from the goods manufactured, sold, or dealt in by others. Such a mark or symbol is the exclusive right of the user when recognized by law. Most countries give special statutory protection to such trade-marks as are registered according to law. The essence of a trade-mark is that it distinguishes the owner's goods from those of another.

The trade-mark is of importance in the selection of farm machinery because of what it stands for. Manufacturers spend many years and much money in building a reputation and establishing the trade-mark on their goods. After their reputation and trade-mark are thoroughly established and well known among the trading world, they will continue to try to maintain the same standards. It is not always possible to judge a machine by its appearance and to determine whether good materials are used in its construction. It is impossible to tell whether a piece of material is good or bad simply by looking at it, especially after it has been painted. Therefore, if it has a trade-mark backed by a firm that has a good reputation, the manufacturer of such implement is behind that particular piece of machinery. If any defect occurs within a reasonable length of time, the firm will make it good. In other words, then, we may say that the trade-mark of a machine is a guarantee of what lies beneath the paint. Look well to the builder of your machine when you are judging and preparing to invest.

76. Trade Name.—The *trade name* is the name by which an article is called among dealers, or we may say it is a name given by a manufacturer or merchant to an article to distinguish it as one produced and sold by him. It is an entirely different name from the trade-mark. If the trade-mark consists of a name, for example, "Avery," that name will be stamped on a machine. On the same machine another name will probably be found, such as "Champion," "Bob Cat," or "Oriole." The word "Avery" will be found on all implements made by that company but "Champion," "Bob Cat," and "Oriole" is the trade name and will be found only on one particular class, such as mowers or plows. What is true of the trade-mark, with reference to its becoming well known, is also true of the trade name. Practically every machine made by standard manufacturing companies has a trade name to go along with the trade-mark. It is the aim of the manufacturer to have its trade name so well known among the users of such implements that it may be on the tongue of everyone.

77. Repairs.—Before considering the purchase of any machine, it is well to look into the source of repairs. Can repairs be had near at hand, or will it be necessary to send several hundred miles away to secure them? No farm implement has yet reached the stage of perfection where it will not break, wear out, or meet with accidents; therefore, it will need repairs. Many times the saving of a crop depends upon the speed with which repairs can be secured. If breakdowns occur in the midst of plowing, planting, or harvesting, they may cause so much delay that the crops will be lost. The larger implement companies maintain repair supplies at many points so that they may render quick service to every part of the country. The machine should be examined to see whether it is accessible for making repairs when needed. Provision should be made in all implements for taking up the wear of bearings and gears. Look well to the source of supplies before buying a machine.

In making up the order for repairs that are needed, be sure to secure the following information:

1. The name and address of the manufacturer.
2. Trade name, model number, year made or purchased.
3. Number of the part wanted.
4. If the number of the part cannot be determined, then get the numbers of the parts with which it works.

78. Design.—Design is the arrangement of the parts to show the difference of make-up in machines of the same type. Manufacturers may put out the same line of implements but they will not be exactly alike. It is this difference of the arrangement of the elements that makes up the design of the machine. In studying the general construction of the

machine, keep in mind the number of castings, gears, and points of wear. The simpler the machine the better it is from the standpoint of design. Avoid machinery that is complicated. The fewer parts there are to wear or take care of, the better the machine will be for the average farming man. The machine should be designed to give sufficient strength. Points to keep in mind while judging a machine are, does it look substantial enough? will it do the work required of it? is it practical? If there is any doubt, it is best to buy the machine upon the condition that it will do the work planned. Such conditions should be put in writing.

79. Workmanship.—Machines for the farm should be well built and finished. Many makes of machinery may be of good design yet finished so roughly that they indicate poor workmanship. The time is past when anything will do for the farmer, for today he is needing and using machinery that calls for just as much inventive genius to develop and mechanical skill to manufacture as the machines used in most of the trades or professions. Farm implements should be judged on their workmanship. Such things as the snug fitting of bolts, gears, and bearings and the means of lubrication should be considered. See if the nuts are provided with lock washers or some other means to prevent losing them. All oil holes should be provided with covers to prevent grit and dirt getting down into the bearings. In general, does the machine have a finished look or does it look rough and unfinished?

80. Ease of Operation.—Many implements that look well are found to require an unnecessary amount of power and labor to make them operate successfully. Of course, it is not always feasible to have the machine demonstrated to see if it will operate easily; nevertheless, such things should be considered in the selection of the machine. The ease of operation may simply depend upon the correct adjustment. It is not an uncommon thing for a farmer to purchase an implement, take it home and after attempting to use it, condemn the machine because of its hard operation. He may go so far as to take it back to the dealer and ask for his money back. If the dealer is a good one, he will usually take the machine out, have the farmer go along, make the necessary adjustments, and see that the machine is running perfectly before he turns it over to the farmer.

81. Adaptability to Work and Conditions.—There are many implements on the market which are not adaptable to every condition. A machine may work in one locality and be an absolute failure in another because it is adapted to certain soil conditions or types of crop grown. To take an example: Tools built for the Southeastern and Gulf Coast states are not suitable for use in the Southwestern states, New Mexico or Arizona, because of the difference in climate, which influences the

methods of preparing the seedbed, planting, and cultivating. Heretofore, the manufacturer has been depended upon to send the right implement to the right locality, but the farmers in these localities should look out for themselves because there are some manufacturers who are unscrupulous enough to sell anything they can.

82. New Devices.—If one will take the trouble to look into the farm-implement trade journals, he will be surprised at the many new devices that are patented from time to time. The majority of these new inventions have not been tried out but are simply the idea of some man who thinks he has a money-making proposition. Most of them will never be heard of again. It is a good plan to follow the instruction of Benjamin Franklin, who said, "Never be the first to try the new, but never be the last to give up the old." In other words, let someone else try out the machine first and see how it works and how it stands up, or at least have it thoroughly demonstrated. If the machine proves to be a good one, adaptable to local conditions, economical, and a laborsaving device, then do not hesitate to invest.

83. Where to Buy and Why.—Many people do not well consider where they should purchase a machine. There are five possible places:

1. The factory.
2. The branch house of the factory.
3. The local dealer representing the branch house.
4. The jobber.
5. The mail-order house.

The question is, from which of these five places would it be best to purchase a machine? If purchased from the factory, would the price be any better than if purchased from the home-town dealer? Most factories are located close to the source of fuel supply and construction material, such as iron. The result has been that most of the factories are located around the Great Lakes. If a man living in Texas wanted to see the machine before purchasing it, he would have to pay railroad fare to and from the factory, which would add materially to the cost of the machine. However, there are one or two small implement concerns within the borders of Texas. After the man had reached the factory, could he get better prices than if he went to his local dealer? In practically every case he would not. In fact, most factories would refuse to sell him and refer him to his local dealer.

All factories that are of any size will distribute their machinery as follows:

Factory to branch house.
Branch house to local retail dealer.
Local retail dealer to farmer.

The others that are not large enough to maintain branch houses will place their machinery in the hands of jobbers. Branch houses are usually located at a distributing point which will best serve their district. This place may still be quite a distance from the buyer. The same thing would be true in going to the branch house as if the man had gone to the factory. He would not get any better price than he would get from the local dealer. In addition, the freight charges would be greater because of the small shipment.

The smaller manufacturers cannot establish and maintain branches and, consequently, must place their goods in the hands of jobbers or middlemen who sells them to dealers, who, in turn, sell to the farmer.

The best place to purchase farm equipment is from the local dealer who handles a line of farm implements of a reliable manufacturing concern. He buys in large quantities, usually car-load lots, thus getting a low freight rate. This dealer will give as good a price as can be secured at the factory or branch house. If he is a good dealer he will have an established place of business and carry a supply of implements together with repairs for them. He will also know enough about the line to give beneficial assistance in setting up and servicing the machine, seeing that it will operate satisfactorily, and maintaining a local source of repair supplies which will aid materially in avoiding delays.

How about buying machinery from the mail-order house? Such houses do not handle what is called a *standard line* of machinery. The catalogue prices may be slightly under those quoted by the home dealer, but there is the delay of waiting for the goods, as well as buying something that has not been seen. If the machine should get out of order, break, and need repairs, there is no supply closer than the mail-order house. The average dealer will not consider supplying repairs for such implements; therefore, the owner of the machine will have to order his own repairs. Much delay, of course, will be involved.

Considering all factors, the best place for the average farmer to purchase machinery is from the local dealer. He sells a standard line of implements and as a rule he maintains a supply of repair parts. He is in a position to give service, advice, and demonstrations if desired.

Other factors to consider in addition to the foregoing are need of the machine, cost of the machine, cost of operation, cost of repair, power required to operate the machine, and years of service to be expected.

PART III

SOIL-PREPARATION MACHINERY

CHAPTER VII

MOLDBOARD- AND DISK-PLOW BOTTOMS

84. Influence of the Plow on Man.—When man grasped a crooked stick and began to till the soil he took his first step toward civilization. With each phase in the development of the plow, there has been a corresponding advance in civilization. In the beginning one man, even though he gave all his time and energy to the task, could till only a small acreage. Later, animal power was applied and the acreage per man was increased. Now, with the large amount of mechanical power available, the acreage per man has been very materially increased. Thus, man can now produce more foodstuff than is necessary for his own sustenance and can furnish food to many who are working at other tasks. Hence, we can say that the plow is the foundation of civilization. In the production of all kinds of crops and in the preparation of a seedbed for them, the plow is the first tool used and it is thus the basic tool of the farm. With the plow the ground is broken and pulverized into small particles; trash on the surface may be left on the surface or completely covered. One not familiar with the nature of the soil, the influence of water, air, and temperature upon its physical condition, and the action of the plow upon it may think that the plow is a very simple tool. But those who are familiar with soil conditions and the plow adjustments necessary to obtain the best results know that the plow is the most important and complete tool on the farm, requiring the consideration of more factors for proper adjustment than does a gas engine. Usually, it is thought to require very little adjustment and practically no care at all.

85. Why Plow?—A thoughtful analysis of the objects of plowing given in the following paragraph shows that a number of definite benefits are obtained by good plowing. The whole premise of high-yield crop production is based on the stirring of the soil with some type of implement, usually a plow, to provide a well-pulverized seedbed. In low-rainfall areas, such as Montana, the Dakotas, and the western edge of the Great Plains, many farmers stir the subsurface without turning under

and burying the crop residue. This reduces wind erosion. Experiments have shown that in areas receiving an annual rainfall of 20 inches or more, plowing is necessary to maintain crop yields. Certain soil types, like the heavy clay, are not adaptable to plowless farming because of their texture. Under humid conditions, unless the crop residue is well buried, insects and plant diseases build up and reduce yields. A soil well pulverized by plowing will absorb rainfall and retain moisture for crops, while the unplowed soil will lose most of the rainfall by runoff. Pulverizing the soil areates it and enhances the activity of microorganisms and bacteria, causing rapid oxidation and decay of crop residues. Stirring the soil is an aid to nitrification and the liberation of plant nutrients within the soil.

In the preparation of the seedbed it is necessary to keep in mind some of the benefits to be derived from such an operation. With the plow we strive to accomplish the following results:

1. To obtain a deep seedbed of good texture.
2. To add more humus and fertility to the soil by covering vegetation and manure.
3. To destroy and prevent weeds.
4. To leave the soil in such condition that air will circulate freely.
5. To leave the soil in such condition as to retain moisture from rain.
6. To destroy insects, as well as their eggs, larvae, and breeding places.
7. To leave the surface in a condition to prevent erosion by winds.

The two kinds of plows in use are known as *moldboard* plows and *disk* plows. The moldboard plow is more generally used. This kind of plow is adapted to many kinds of soils and is well suited for turning under and covering vegetable crops. The disk plow is used in soils that are sticky when wet and hard when dry.

THE MOLDBOARD PLOW

86. The Moldboard Plow Bottom.—The real unit of the plow, called the *bottom* or *base*, is composed of those parts necessary for the rigid structure to lift, turn, and invert the soil. The parts which form a three-sided wedge are the *share*, the *landside*, and the *moldboard*. These parts are bolted to the *frog* and thus form the bottom. If one looks at the landside of the plow, the parts that cut and lift the furrow slice are in view. Viewed from above, the shape of the bottom is such as to cause the furrow slice to be moved to one side. This is accomplished by the upper part of the share and the moldboard.

87. The Frog.—Figures 69 and 70 show the frog, which is the foundation of any plow bottom. It is an irregularly shaped piece of metal to which the share, landside, and moldboard are attached. Take the frog away and all other parts are useless because they cannot be held

in their proper positions. In most plows the beam is also attached to the frog (Fig. 69).

Frogs are generally made of steel and malleable iron. Steel is used more extensively because it is a light, strong, durable, and easily shaped

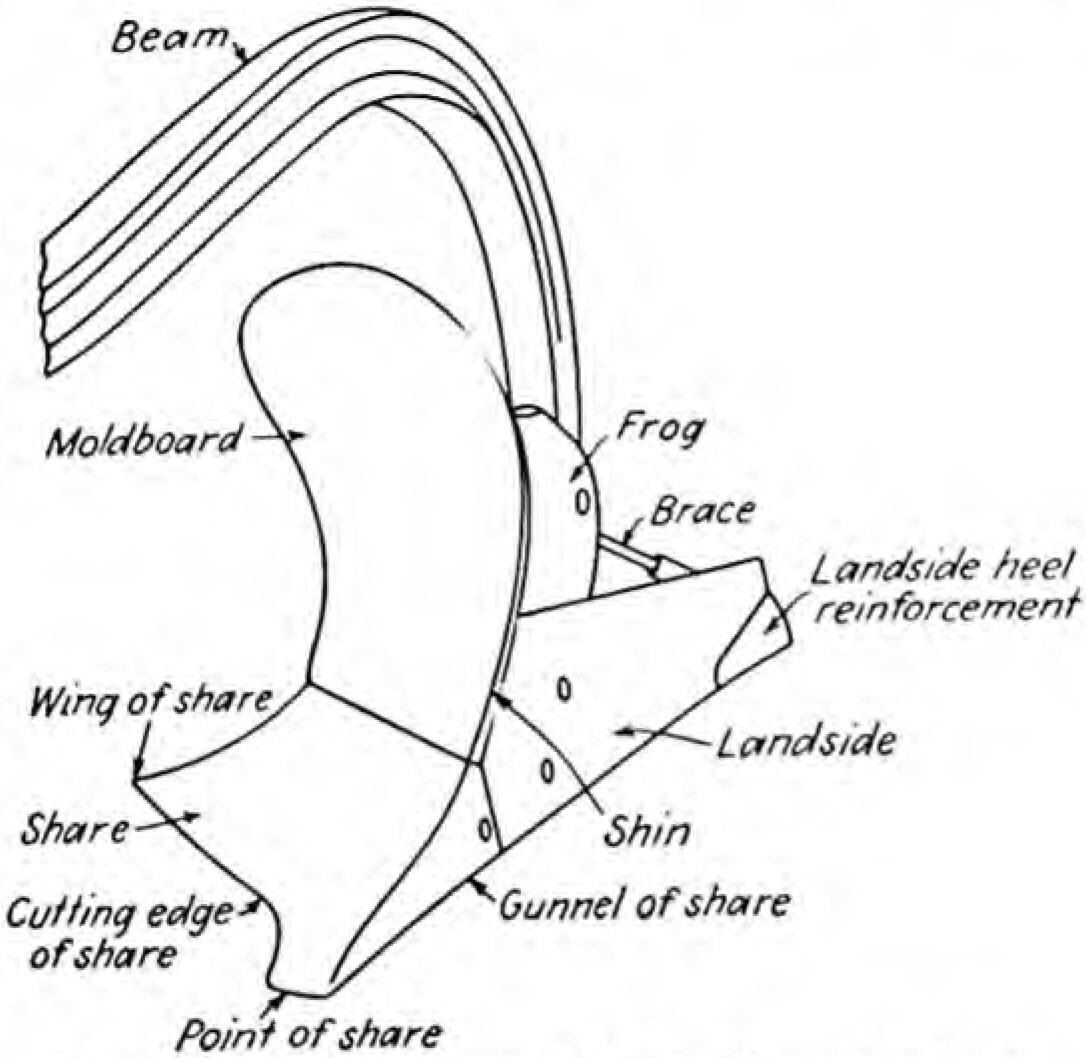


FIG. 69.—The various parts of a plow bottom or base.

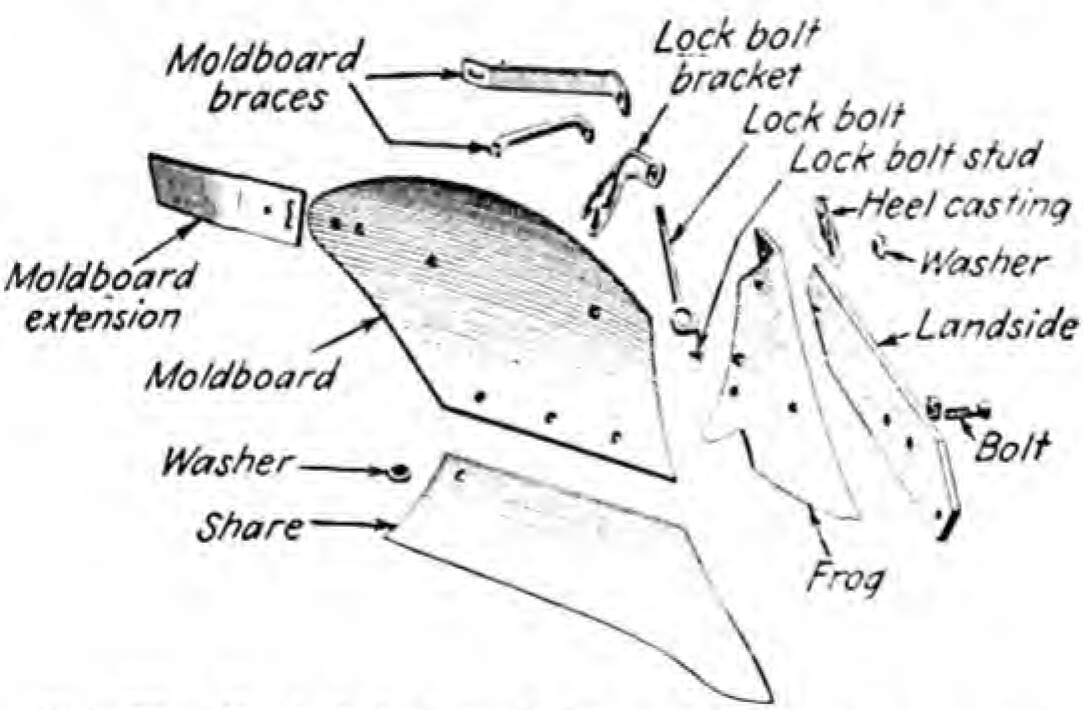
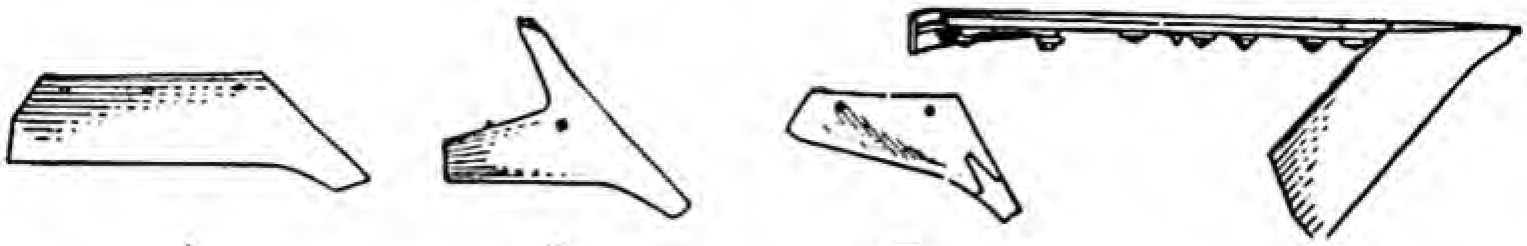


FIG. 70.—Exploded view of the plow bottom and parts.

material. Malleable iron is used for frogs which do not have to be made thin and small.

If the frog is not very large, it is often necessary to reinforce it to prevent bending or breaking. Should the frog of any plow become bent, it is almost impossible to bring it back to the original shape.

88. The Share.—The share (Fig. 71) provides the cutting edge for the plow. The principal parts of the share are the point, the wing, and the



A B C D

FIG. 71.—Kinds of share: *A*, slip share; *B*, shin share; *C*, slip-nose share; *D*, bar share.

cutting edge or throat. The point is the first part of the plow to penetrate the soil. The wing is the outside corner of the cutting edge (Fig. 69). The cutting edge extends from the point to the wing. This edge is curved and forms the throat of the share.

The kinds of shares are slip, shin. bar, slip-nose, and straight. The slip share has no extension to form the landside as does the bar share. The shin share has an extension to form the cutting edge or shin for the moldboard. When a share is replaced with

FIG. 72.—Straight share that does not have gunnel.

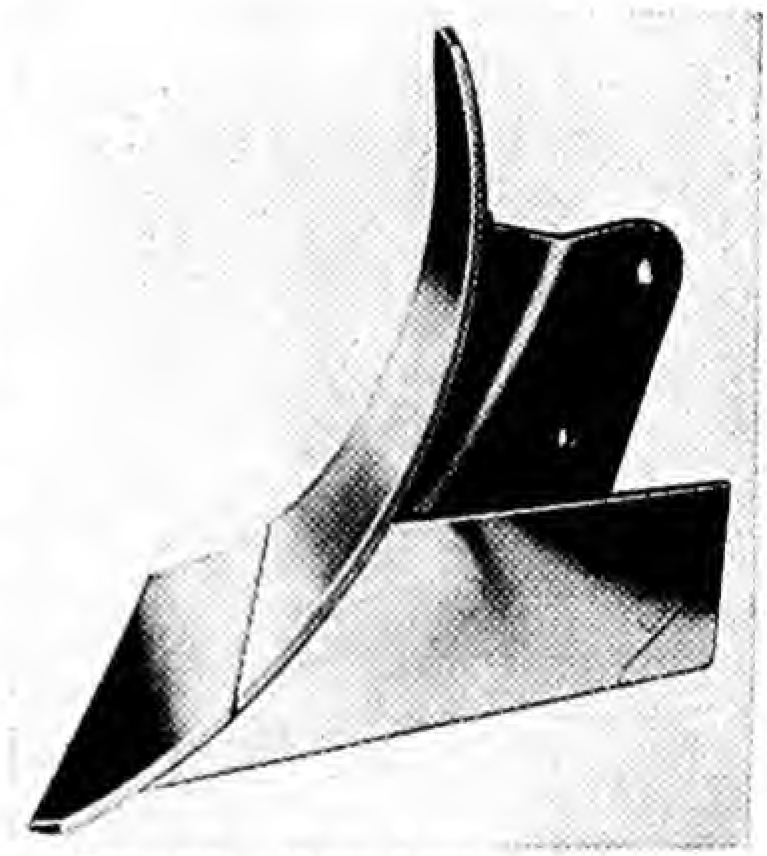


FIG. 73.—Plow bottom fitted with straight share. Note how landside fits against share and moldboard. Note that there are only four parts in the complete bottom.

a new edge, the cutting edge and the shin are new. The slip-nose share is one with a detachable point. The straight share is stamped and shaped in one operation, thus making the manufacturing cost low (Figs. 72 and 73). The materials used in making shares are plain crucible steel, soft-center steel, chilled cast iron, and cast iron.

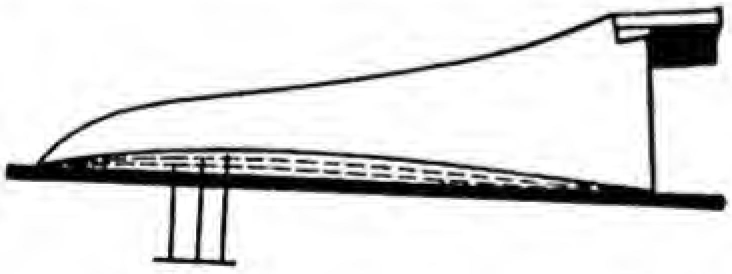


FIG. 74.—Share suction: 1, regular suck—$\frac{3}{16}$ inch for light soil easy of penetration; 2, deep suck—$\frac{5}{16}$ inch for ordinary soil that is dry and hard; 3, double-deep suck—$\frac{3}{8}$ inch for stiff clay soils, gravel land, and other soils where penetration is difficult.

Figure 74 illustrates three degrees of suction: regular suck, deep suck, and double-deep suck. The amount of suction is around $\frac{3}{16}$, $\frac{5}{16}$, and $\frac{3}{8}$ inch, respectively. Walking plows are usually equipped with regular-suck shares. Wheel plows, both horse and tractor drawn, are equipped with the deep suck.

89. Cast-iron Shares.—Cast-iron shares are made for the cheap walking plow and are very easily broken. The plow must be handled carefully at all times. A sharp blow or a shock will break the share, which must then be replaced with a new one, as it cannot be welded by the ordinary blacksmith. Very little care is taken in the manufacture of cast-iron shares, which results in nonuniformity and poor fitting.

90. Chilled Cast-iron Shares.—Chilled shares do not rust easily and do not wear so rapidly as the cast-iron or steel ones. They are especially adapted to sandy and gravel soils but work well in a clay or loam soil.

91. Plain Steel Shares.—These shares are made of steel that is of the same structure throughout. The land face or gunnel is welded onto the share proper by a lap weld.

92. Soft-center Steel Shares.—The soft-center steel shares are being used extensively on steel plows and for soils that do not scour well. A plow scours well when the soil does not stick to the surface of the share and moldboard. The very hard surface takes a good polish and consequently will scour where other metals will not. However, they are more expensive than any of the other types. Since soft-center steel shares have been placed on the market the many attempts at imitation can be easily detected by the method described under Soft-center Steel. Many shares are reinforced by having an extra patch welded on the upper side of the point (Fig. 75).

FIG. 75.—Soft-center-steel share point (landside toward figures): A, patch of hard steel for reinforcement. 1 and 3, hard steel; 2, soft steel; 4, steel landside, lap weld.

93. Slip-on Share Point.—Figure 76 shows a ready-made wear-resistant plow point that slips on over the regular point. Spring clamps hold it in place. Two sizes are made—12-inch and 14-inch. These points should be used on new, unworn shares.

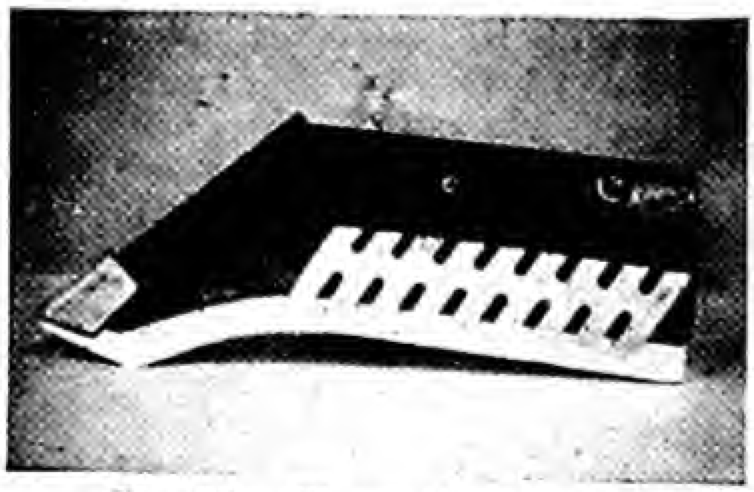


FIG. 76.—Slip-on share point.

94. Sharpening Soft-center Steel Shares.—When sharpening soft-center steel shares special care must be taken because of the peculiar way in which they wear. Strange to say, the underside wears away faster than the upper.

Heat only to a cherry red, or 1470° F. The share should be placed in the forge flat and not vertically (Fig. 77). If placed vertically, heating

cannot be confined to the edge. When heating extends the greater part of the way back across the share, warping will likely occur. Heat only a small portion at one time and begin at the point, working back to the wing. Hammering should be done only on the upper side with the lower side flat on the anvil (Fig. 77). This is necessary because the thicker layer of hard steel can be drawn out over the soft steel in the center and the thin layer of hard steel on the underside. If the hammering is done from the underside, the soft center will be left exposed, and very likely the top layer will be loosened and parts flake off. Care should be taken not to destroy suction in the share.

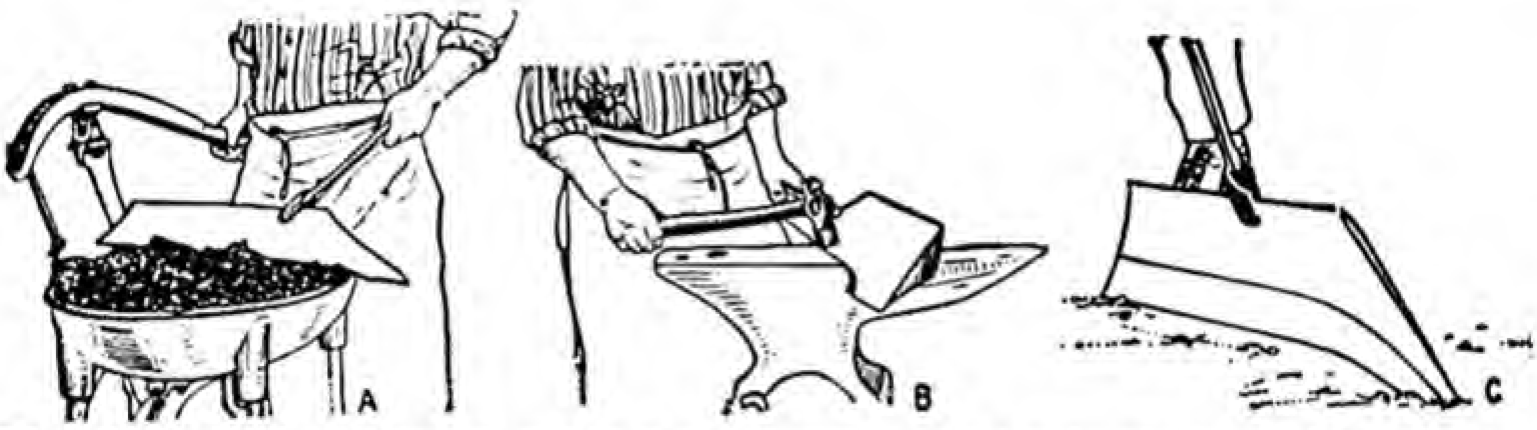


FIG. 77.—Steps in the sharpening of a plow share: *A*, heat only the part of the share to be pounded out; *B*, hammer on the top side; *C*, the right way to place a plowshare for cooling.

95. Sharpening Crucible-steel Shares.—Even though they are solid throughout, crucible-steel shares are best sharpened in the same manner as soft-center steel shares. They can be hammered on the underside, however, but in doing so there is more danger of disturbing the set.

96. Sharpening Chilled and Cast-iron Shares.—These materials cannot be heated and hammered to draw out the edge because of their brittleness. Instead of being hammered they must be ground, and this should be done on the upper side. A safe rule to follow in sharpening any share, whether it be soft-center or crucible steel, chilled or cast iron, is to work from the upper side.

97. Sharpening the Straight Share.—The straight share shown in Fig. 72 does not require sharpening.

98. Repointing Shares.—Shares that are badly worn or that have been sharpened a number of times should be repointed by welding a 6-inch piece of steel bent U-shaped to both the lower and upper sides of the point.

99. Treating the Cutting Edge of Shares.—Steel shares can be used much longer without sharpening by applying a hard metal, like Stellite, to the cutting edge with a welding torch. Care should be taken to get the hard metal well distributed on the bottom side of the cutting edge.

100. Points of Bearing.—There are three points of bearing on an ordinary walking plow, namely, the point of the share, the wing of the share, and the heel of the landside. These three points are the only points that

actually come in contact with the furrow sole, as can readily be seen as the plow rests on the floor.

101. Wing Bearing.—The amount of *bearing at the wing* (Fig. 78) will greatly influence the operation of large walking plows. Plows mounted on wheels do not require wing bearing, as they are controlled by the lead of the furrow wheels. The amount will vary from almost

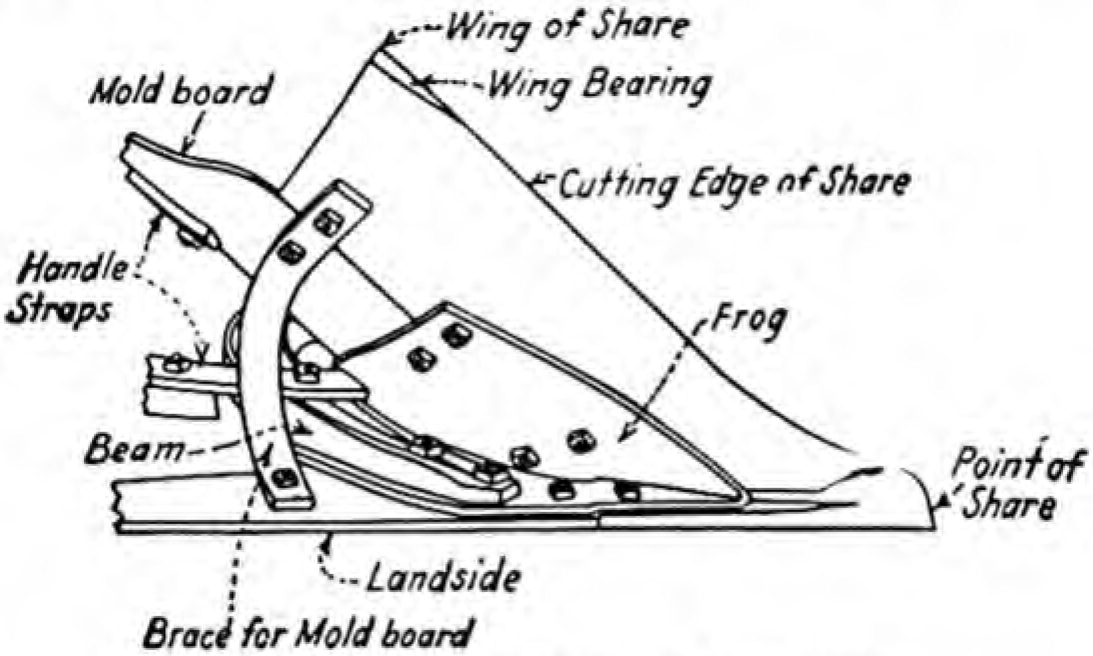


FIG. 78.—The underside of a plow bottom.

nothing to $1\frac{1}{2}$ inches according to the size of the plow and soil conditions. The wing bearing for a 12-inch walking plow is about $\frac{3}{4}$ inch, for a 14-inch plow $1\frac{1}{4}$ inches, and for a 16-inch plow $1\frac{1}{2}$ inches. The amount of wing bearing is measured as shown in Fig. 79. It is the amount of the share that is in contact with the straightedge at *D*. The effect of wing bearings will be discussed under Troubles.

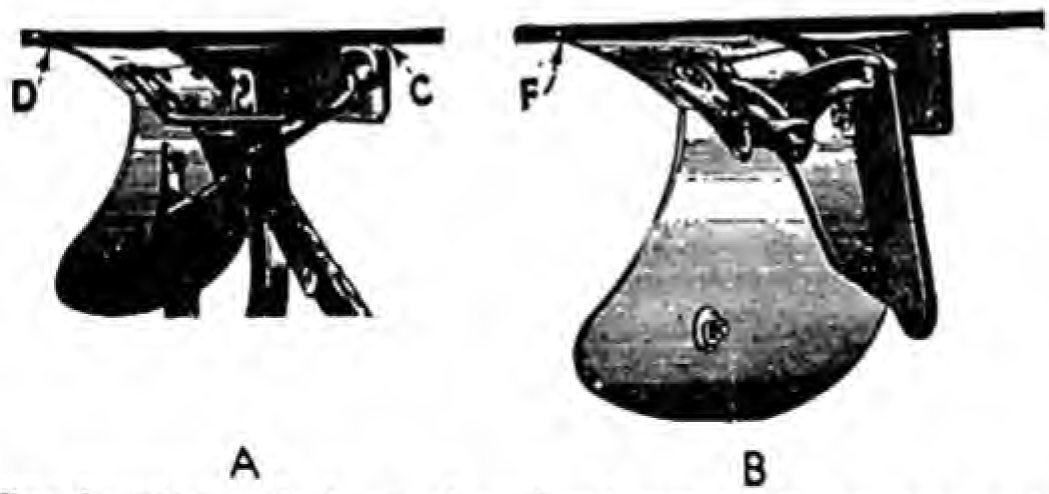


FIG. 79.—Wing bearing. *A* shows the wing bearing on a walking plow, *B* shows the small amount required for a wheel plow. To measure the wing bearing at *D*, place the straightedge across the heel of landside at *C* and wing of share at *D*. The wing bearing is the amount in contact with the straightedge at *D*.

102. Vertical or Down Suction.—This is the bend downward of the point of the share to make the plow penetrate the soil to the proper depth when the plow is pulled forward. The amount of suction will vary from $\frac{1}{8}$ to $\frac{3}{16}$ inch depending on the style of the plow and the soil it was made to work in. This suction can be measured on a walking plow by placing a straightedge on the bottom of the plow extending from the heel of the

landside to the point of the share, then measuring vertically the greatest distance from the straightedge to the plow bottom (Fig. 80).

On all moldboard plows mounted on wheels, it will be noticed that the heel of the landside does not touch the floor when properly set; the vertical suction in this case will be the amount the heel of the landside is elevated above the floor (Fig. 81). Ordinarily this is about ½ inch with the average length landside. It is claimed that the straight share (Fig. 72) has suction built into the full width of cut.

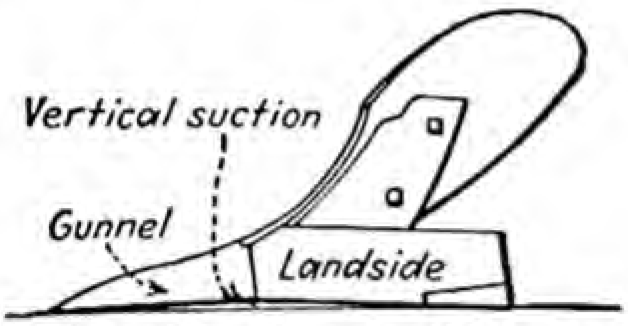


Fig. 80.—On a walking plow the amount of vertical or down suction should be measured at the intersection of share and landside.

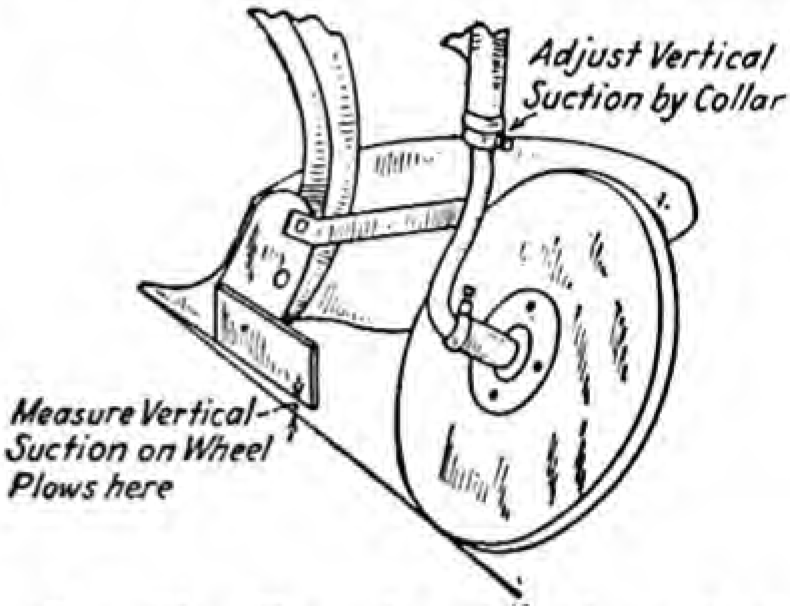


Fig. 81.—How the vertical or down suction should be measured and adjusted on a wheel plow.

103. Horizontal or Land Suction.—Horizontal suction is the amount the point of the share is bent out of line with the landside (Fig. 82). The object of this suction is to make the plow take the proper amount of furrow width. Horizontal suction is measured by placing a straightedge on the side of the plow extending from the heel of the landside to the point of the share, then measuring horizontally the greatest distance from the straightedge to the plow bottom (Fig. 82). The amount is usually about $^3/_{16}$ inch.

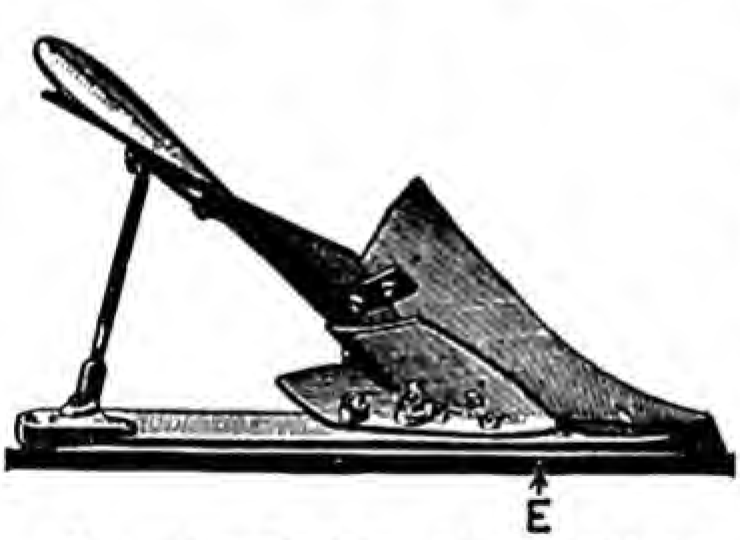


Fig. 82.—Position of straightedge to measure the horizontal or land suction at *E*.

104. The Landside.—The landside is that part of the plow bottom which slides along the face of the furrow wall (Fig. 69). It helps to counteract the side pressure exerted by the furrow slice on the moldboard. It also helps to steady the plow while it is being operated. Landsides are divided into three kinds: high, medium, and low. The size is determined by the style of the plow and the depth of the furrow it will cut. Landsides are considered low up to 4 inches; medium from 4 to 6 inches; and high from 6 to 8 inches in height. There are many types of landsides varying according to the shape. Some are made rectangular, others are flanged in various ways. Some are flanged on both sides at

the bottom, forming an inverted letter *T*. Those that are flanged only on one side form the letter *L*. They may be inclined inward under the plow to prevent the plow from sinking down at the rear. Since the heel of the landside forms one of the points of bearing, it is sometimes necessary to replace it, because of wear and the loss of suction in the plow bottom. Some landsides are built with detachable heels (Fig. 69) that may be renewed when necessary. The materials used in making landsides are cast iron, solid steel, and soft-center steel.

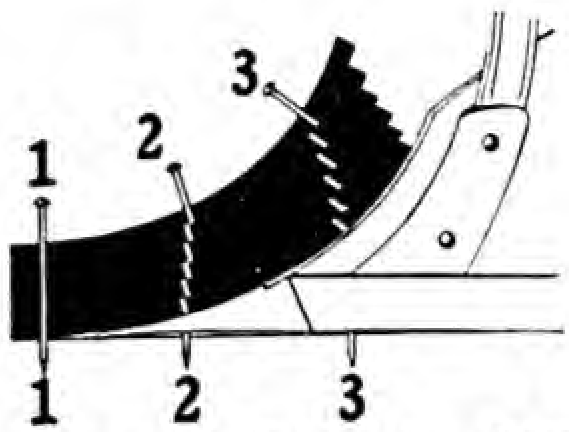


FIG. 83.—Pulverizing effect of plow bottom on soils that scour well. Note that the soil does not begin to pulverize until the furrow slice starts up the curved surface of the share as illustrated by pin No. 2. Most of the pulverizing takes place on the concave surface of the moldboard.

105. Types of Moldboard According to Shape.—The moldboard is that part of the plow just back of the share. It receives the furrow slice from the share and turns it. When the action of the plow bottom upon the soil is considered, the moldboard (Fig. 69) is the most important part of the plow because it is upon the moldboard that the furrow slice is broken, crushed, and pulverized (Fig. 83). Different soils require differently shaped moldboards to give the same degree of pulverization. For this reason moldboards are divided into several classes, namely,

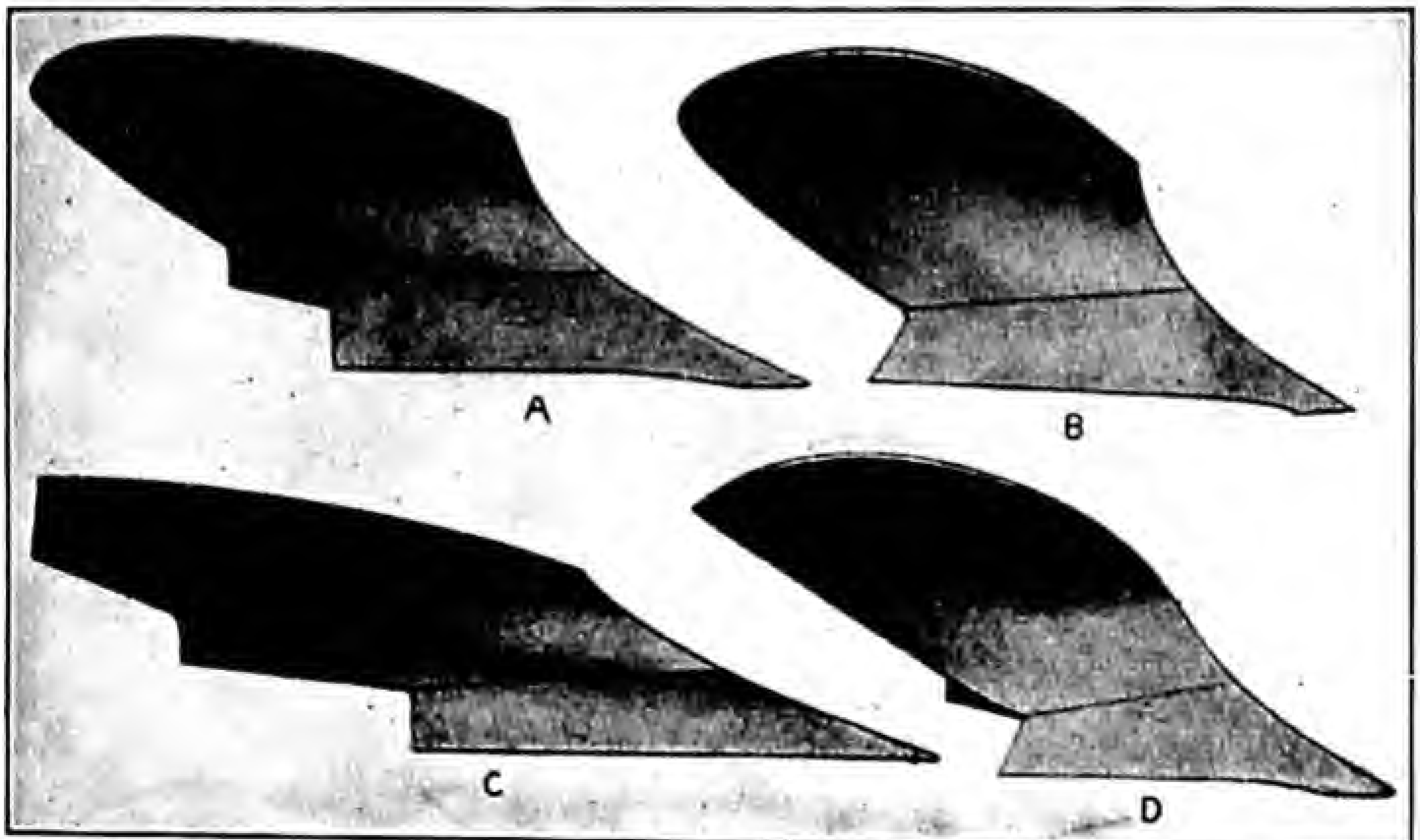


FIG. 84.—Types of plow bottom: *A*, general purpose; *B*, stubble; *C*, sod or breaker; *D*, special blackland.

stubble, general purpose, blackland, and sod (Fig. 84). In classifying moldboards, it should be kept in mind that there are hundreds of shapes of each class. Such diversity of shapes has resulted in an attempt by manufacturers to make a plow that will do good work in all types of

soils, but one that will work successfully everywhere is yet to be made. A special shape called the *blackland* bottom (Fig. 84) is used extensively in Texas and in other localities where the soil does not scour well.

The general-purpose moldboard is a combination of the sod and stubble types and can be easily used for sod or stubble land. It has less curvature than the stubble moldboard. Hence, it is called a *general-purpose plow*.

The stubble type of moldboard is broader and bent more abruptly along the top edge. This causes the furrow slice to be thrown over quickly, pulverizing it much better than the other types of molds. This type is best suited to work in soil that has been cultivated from year to year, called *stubble soil* because of the fact that the stubble of plants from the previous crop is still on the land. Unlike the sod plow, the furrow slices lap upon one another.

A sod or breaker bottom is designed to work in unbroken prairie sod land and in land that has remained idle for a number of years. This type of moldboard is constructed so as to have a long, gradual, augerlike twist, the object being to turn the slice completely upside down, covering all vegetable matter thoroughly. One furrow slice is not lapped upon another because air spaces would be left which would prevent rapid decay and at the same time make it impossible for plants to live and grow.

106. Types of Moldboards According to Construction.—There are three classes of moldboards according to the manner of construction, namely, the solid, slat, and rod.

FIG. 85.—A plow designed for plowing at high speeds.

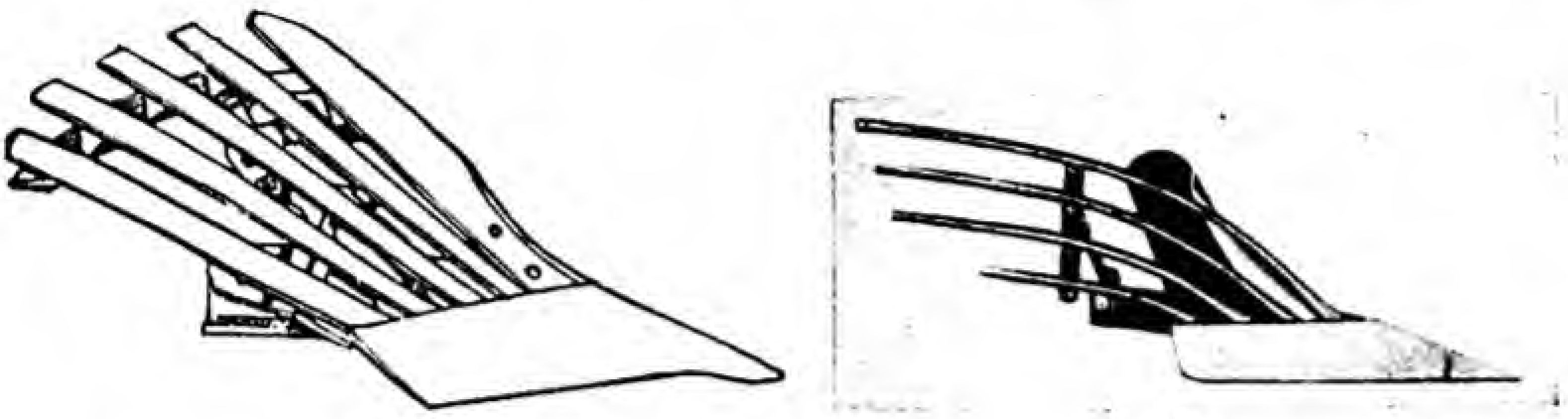
The solid type has no perforations or sections cut out to break the smooth surface of the plow, as shown in Fig. 84.

Slat moldboards (Fig. 86) are those that have sections cut out lengthwise of the moldboard leaving only about half the surface to come in contact with the furrow slice. These are sometimes used where soils will not scour. They are claimed by some to give a more thorough soil pulverization.

The rod type of moldboard (Fig. 86) consists of round rods attached to the plow in such a manner as to form a surface upon which the furrow slice will be turned. There will be little, if any, pulverizing of the soil with this type of board. It is found to be practical and useful in some soils of the prairie type that are sticky and will not shed as they should from solid molds.

Generally, there are three materials used in the manufacture of

moldboards, namely, soft-center steel, crucible steel, chilled cast iron, and, on some of the very cheap plows, cast iron. Soft-center steel moldboards, as shown in Fig. 87, are the best to use under most conditions, because the majority of soils will scour better on this type of material.



A B

FIG. 86.—Special types of plow bottom: *A*, slat moldboard; *B*, rod moldboard.

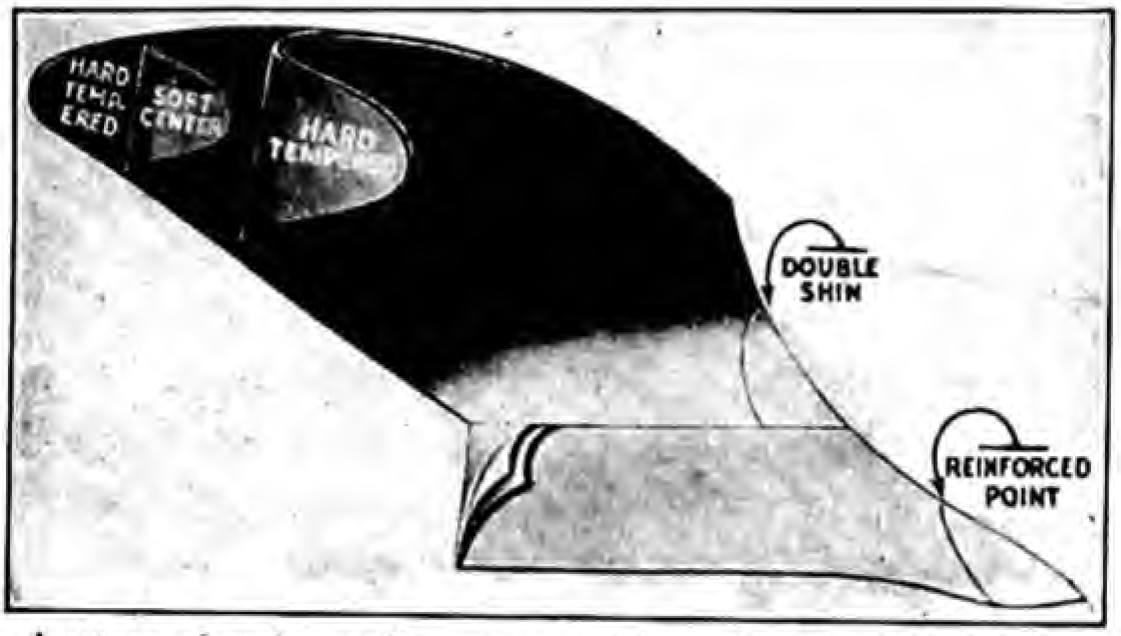


FIG. 87.—Plow bottom showing soft-center moldboard and share and method of reinforcing point of share and shin of moldboard.

FIG. 88.—Detachable shin.

For the Middle West the steel plow seems to give satisfaction in most cases. Because of their wear-resistant qualities due to the hardness of the material of which they are made, chilled plows are better for sandy, gritty, and gravel soils. Chilled plows are adaptable to all parts of the South where there is sandy land, and especially to the yellow-pine districts.

The *shin* (Fig. 87) is the cutting edge of the moldboard, just above

the landside. Detachable shins, as shown in Figs. 88 and 89, are not used extensively; however, they are desirable on stony and gravel soils where wear is excessive.

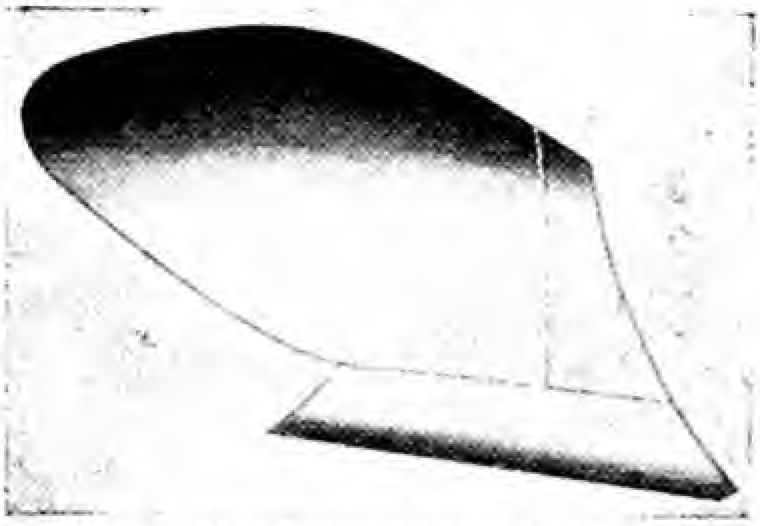


FIG. 89.—Moldboard plow bottom with straight share and renewable shin.

On some moldboards an extension is provided to turn the soil over more gradually and completely.

107. Size of the Plow.—The size of a moldboard plow is its width in inches. This is determined by measuring the distance from the wing to the landside. The rule is held perpendicular to the landside. Walking-plow sizes are 6, 7, 8, 9, 10, 12, and 14 inches, but wheel horse-drawn and tractor plow sizes are 10, 12, 14, and 16 inches. Special brush plows may be as large as 18 and 20 inches.

108. The Furrow.—The *furrow* may be defined as the opening left in the soil after the furrow slice has been removed by the plow bottom (Fig. 90). The *furrow slice* is the soil that was cut, raised, and inverted by the share and moldboard. The *crown* or bank is the upper surface of the furrow slice after being inverted. The *sole* is the bottom of the furrow on which the plow bottom slides. The *furrow wall* is the unplowed land. The *face* of the furrow wall is the smooth vertical face left by the landside.

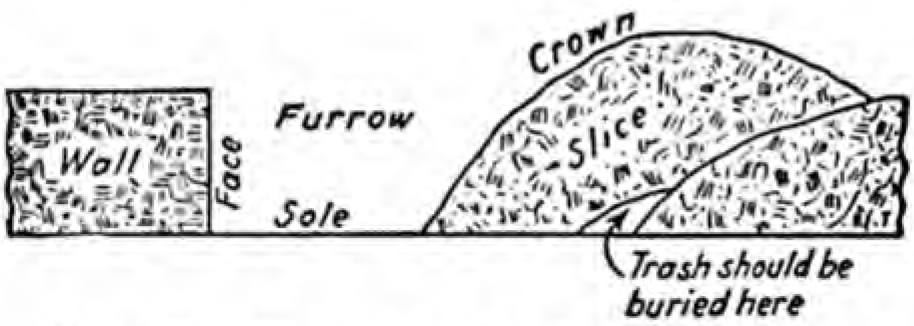


FIG. 90.—The various parts of a furrow.

A *dead furrow* is the trench left in the field after a "land" has been plowed. This trench is slightly wider than twice the width of the plow bottom used. It should not be left open but filled by making a round trip across the field throwing furrows into the trench.

A *back furrow* is the ridge left across the field where a land is started. On the return trip across the field the furrows are lapped on top of those made the first time across the field.

THE DISK[1] PLOW

The disk plow was brought out in an effort to reduce friction by making a rolling bottom instead of a bottom that would slide along

[1] As used in this text, *disk* means a round concave piece of metal, while *disc* means a round flat piece of metal.

the furrow. It cannot be said with authority that after the extra weight is incorporated into the plow it will have any less draft than the moldboard type. The results of the disk-plow usage, however, show that it is adapted to conditions where the moldboard will not work Some of these conditions are as follows: first, the disk plow can be used in ground that is too hard for the moldboard; second, it will scour, using a scraper, in most soils; third, it does not form a hardpan; fourth, the angle of the disk can be changed for hard or loose land.

This type of plow is used in the South and North, and very extensively in the Southwest and the semihumid regions of the Middle West. It is of special value in Texas because of the large areas of soil having a close texture which will not scour on the average moldboard plow. Texas is called by the plow manufacturers a *disk-plow state*. There are large areas of this state, however, where the moldboard plow does work satisfactorily.

The disk-plow bottom is a perfectly round, concave disk of steel, sharpened on the edge to aid in the penetration of the soil. There are several holes for bolting this disk to the malleable casting upon which it fits. The disk is set at an angle both to the plow sole and to the furrow wall. This allows the disk to have a sort of scooping action. The use of heat-treated disk-plow bottoms assures longer life, a smooth cutting edge, and easier penetration.

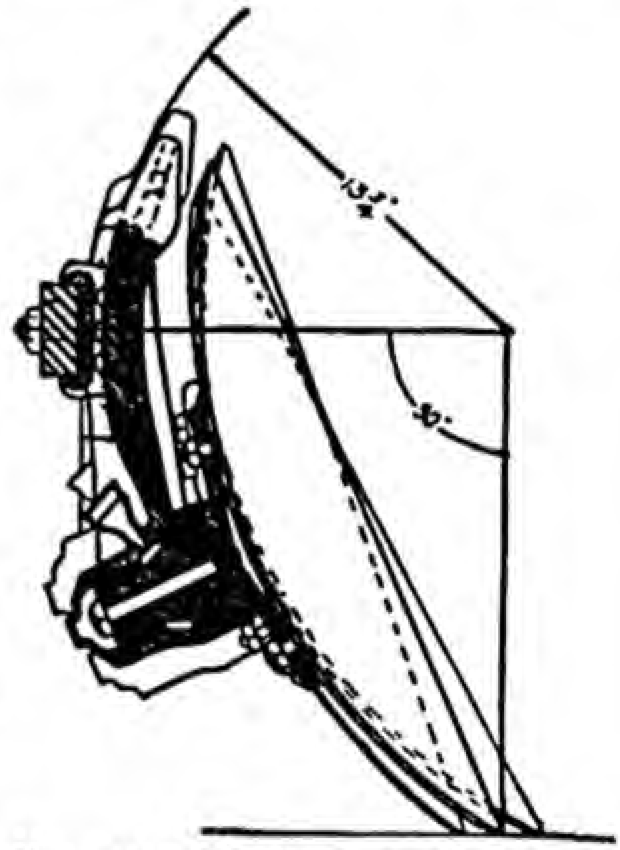


FIG. 91.—Vertical angle of disk can be easily changed.

The malleable-iron bracket to which the disk proper is bolted has an extension forming an axle projection, which fits into a hub in such a manner as to give a close-fitting bearing. These parts are usually chilled to increase their lasting and wearing qualities. Most plows are now being equipped with ball and roller bearings, which allow the disk free action as far as turning is concerned.

When the plow is pulled forward the disk will turn as a result of the action of the furrow slice upon it. The top of the disk is revolving to the tractor operator's left. The furrow slice, then, is cut by the left edge of the disk, brought under and up to the right, and then thrown out to one side. The furrow slice is pulverized to some extent when carried over the concave surface of the disk.

All disk plows should be equipped with a scraper which can be adjusted to work from the center to the edge of the disk. With the aid

of the scraper it is possible to get greater pulverization of the furrow slice. It is also possible to invert the furrow slice much better.

The disk plow can be made to penetrate more easily by setting the disk more in a vertical position (Fig. 91). The flatter it sits the less tendency there will be for it to penetrate. Further to enable the disk plow to take the soil properly, weight is added to the frame and wheels to force the plow into the ground. There is one great difference in moldboard and disk plows: The moldboard plow is pulled into the ground by the suction of the plow, while the disk is forced into the ground by added weight and by the suction of the disk due to the angle at which it is set. The frame of this plow is made of very heavy steel with many large castings to give plenty of weight.

The size of disk plows varies from 24 to 34 inches in diameter. The size is always given in even numbers. Either smooth or notched edges may be obtained. The notched edge is suitable for plowing where there is much trash.

CHAPTER VIII

PLOW ACCESSORIES

The plow bottom and its parts are the real working parts of any plow. All parts other than the bottom can be considered as accessories. However, they are necessary to obtain good work. For the walking plow the handles, beam, and clevis are the principal accessories. Some form of coulter, weed hook, and gage wheel may be used when needed. Other types of plows may have, in addition, harrow attachments, levers, wheels, and a frame upon which the bottoms are mounted.

109. The Beam, Clevis, and Handles.—The *beam* (Figs. 69 and 92) is attached to the plow bottom and extends out to the front to form a suitable means for the team or tractor to draw the plow forward.

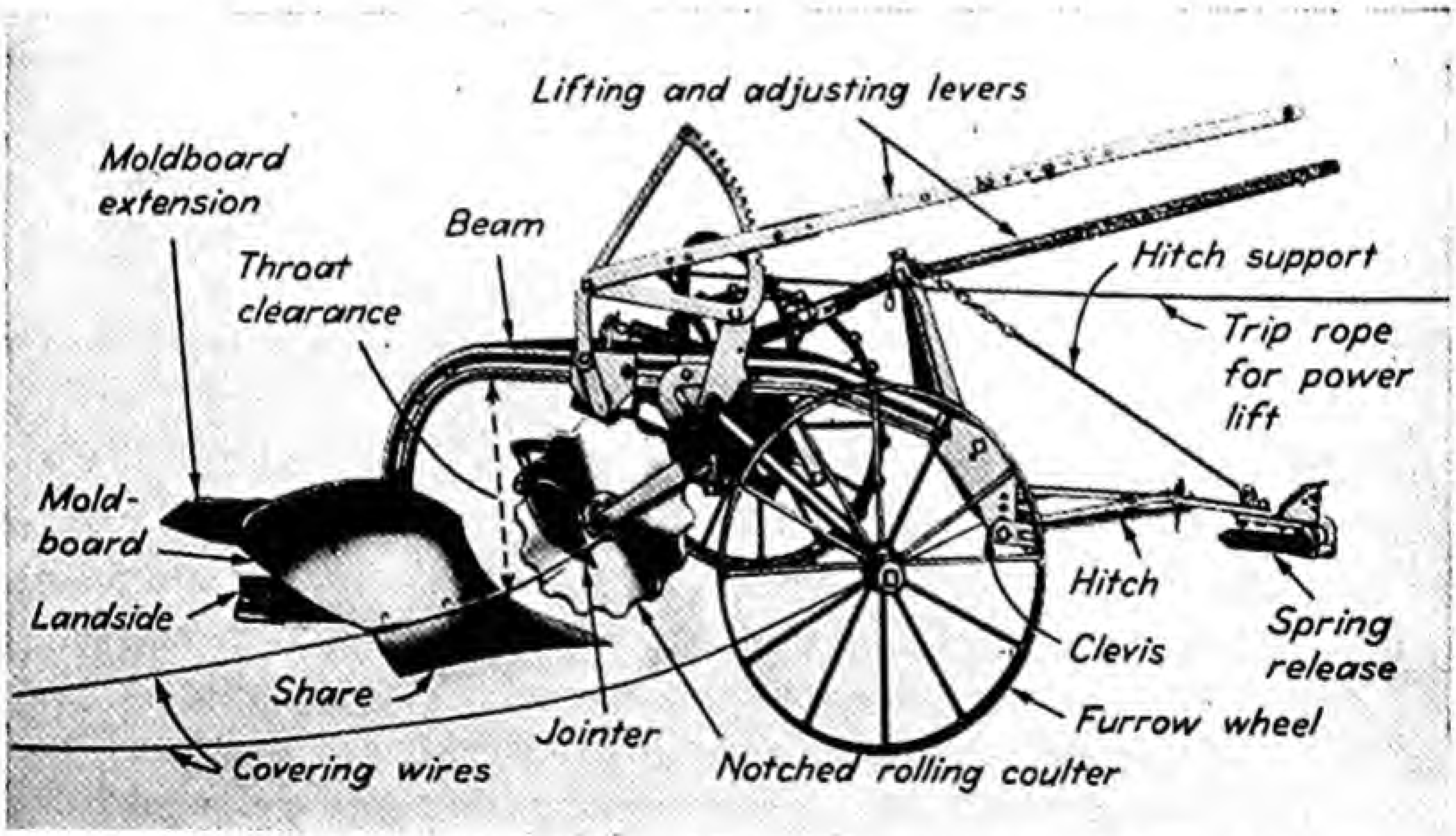


FIG. 92.—Pull-type single-bottom moldboard plow complete with attachments.

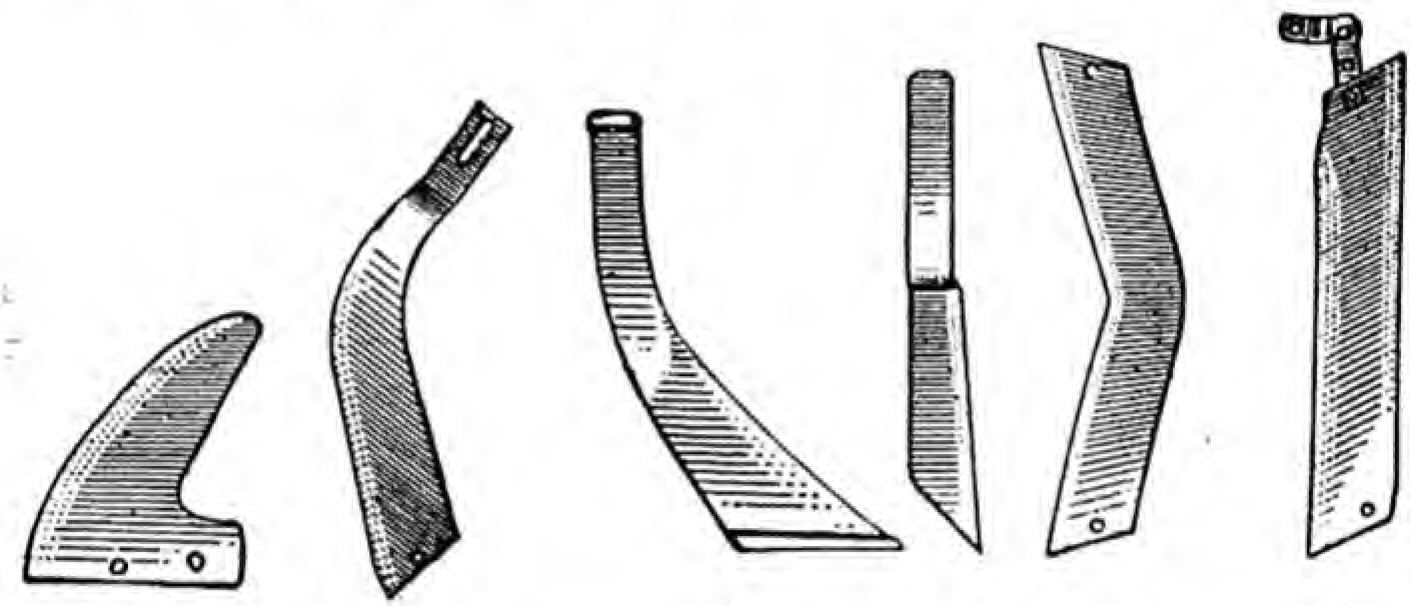
The steel beam is curved in such a manner that it is fastened behind the moldboard, being attached to the frog. It is also curved so that there will be sufficient clearance at the throat of the plow to give ample room for handling the furrow slice as well as trash. The end of the beam to which the clevis is attached curves downward so that it will be in alignment with the center of resistance of the plow bottom and the point at which the plow is attached to the power. Steel beams are made of high-carbon steel and will stand considerable strain without

bending. When bent they are very difficult to reshape to their original curvature and it is better to obtain a new beam. Some steel beams have a special device for landing them at the rear in the same manner as that of the wooden beam.

The *clevis* is a special arrangement at the end of the beam to form a connection with it and the power unit. Provision is made for both horizontal and vertical adjustments. This is necessary in order to bring the center of power and the center of load as near together as possible. It also provides an adjustment for depth and width of furrow.

The *handles* extend to the rear of the bottom and are used to guide the plow.

110. Coulters and Jointers.—Coulters are special attachments placed on plows to cut the furrow slice loose from the furrow wall instead of



A *B* *C* *D* *E* *F*

FIG. 93.—Types of knife coulter: *A*, fin; *B*, knee cutter; *C*, standing cutter; *D*, hanging cutter; *E*, Quincy cutter; *F*, reversible cutter.

allowing the shin of the plow to tear its way through the soil. There are many types of coulters, named according to their shape and manner of attachment to the plow. Coulters are classified as sliding and rolling. Sliding coulters can be classed under two general heads, knife and fin.

Included under the knife coulter are all the hanging coulters, knee cutters, and reversible coulters, sometimes called *double enders*. Types of these are shown in Fig. 93. The hanging coulters are always attached to the beam and allowed to hang underneath, going deep enough into the soil to cut the furrow slice loose. The double enders and the knee types may be attached both to the beam and to the share.

The *fin coulter* (*A* Fig. 93) is an irregular-shaped piece of steel which is bolted to the land face or gunnel of the share and extends upward to cut loose the furrow slice. It is used principally in sod land.

The *rolling* coulter (Fig. 94) is a round, flat, steel disc which has been sharpened on the edge and suspended on a shank and yoke from the beam. The edge of the coulter may be either smooth or notched

(Fig. 95). It is so constructed that it can be adjusted up and down for depth and sidewise for width of cut. This type of coulter is used more than any of the others. The rolling coulter will leave a smooth furrow face and will also cut trash much better than the other types.

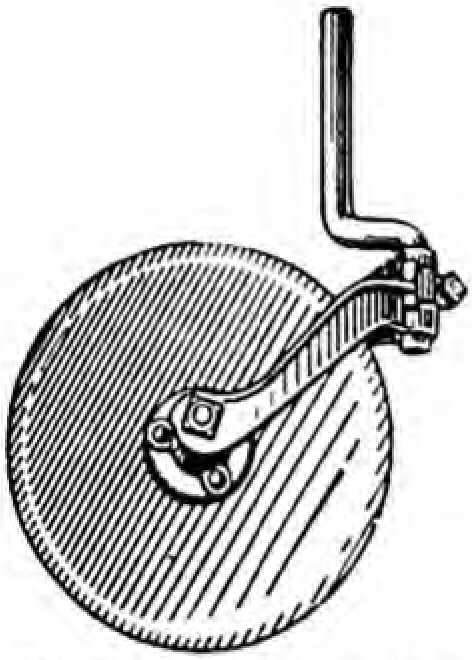


Fig. 94.—Rolling coulter.

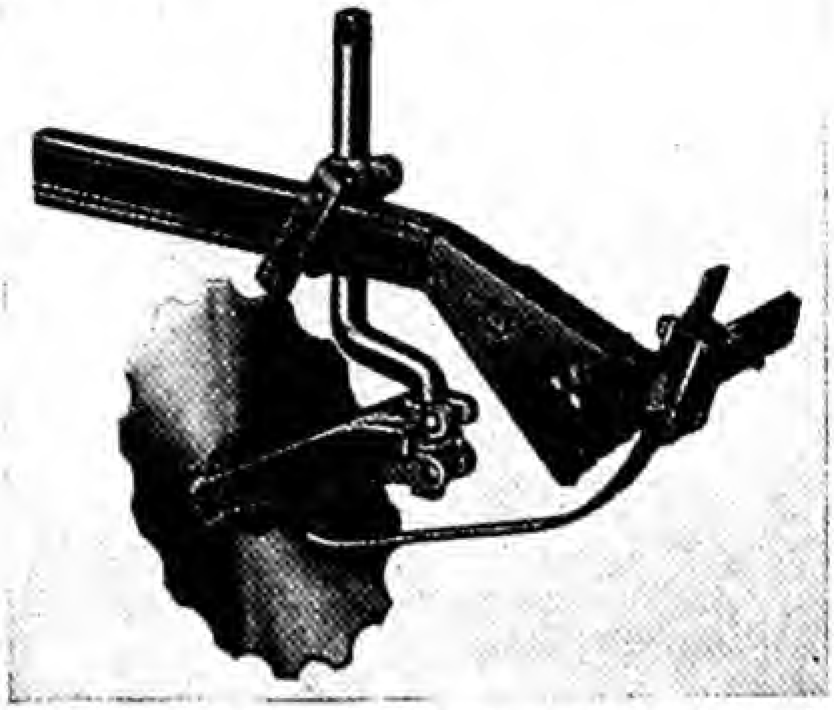


Fig. 95.—Notched rolling coulter with trash spring to hold down heavy stalks.

The *jointer* is a small irregular-shaped piece of metal having a shape similar to an ordinary plow bottom (Figs. 92 and 96). It is a miniature plow. Its purpose is to turn over a small, ribbonlike furrow slice directly in front of the main plow bottom. This small furrow slice is cut from the left and upper side of the furrow slice and is inverted. All trash on top of the soil is completely turned under and buried in the right-

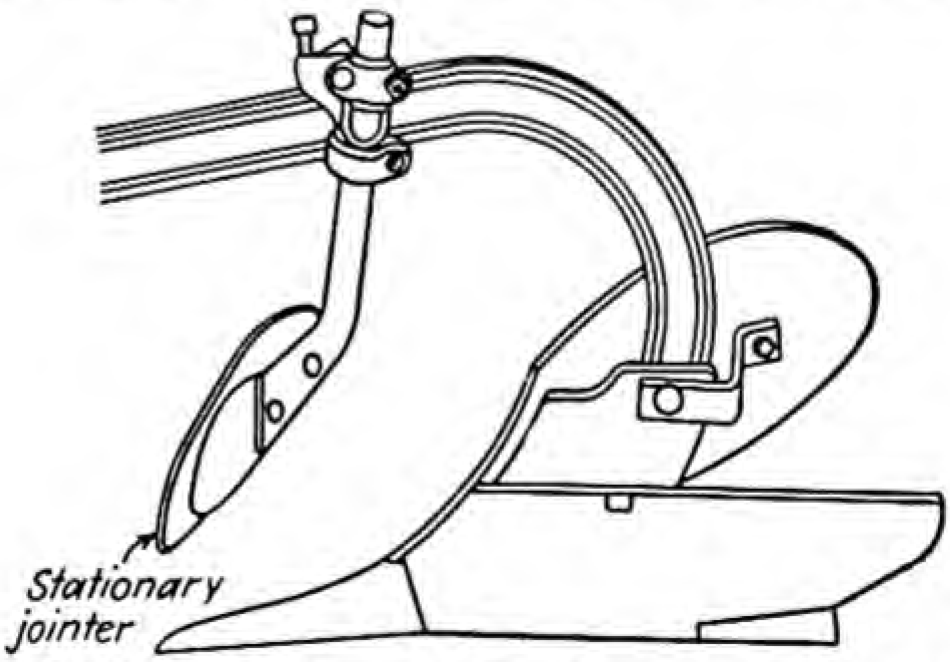


Fig. 96.—Moldboard stationary jointer fastened rigidly to plow beam.

hand corner of the furrow. The *swivel* or *self-aligning disk jointer* swings to one side when an obstruction is encountered and automatically swings back after it has been passed over (Fig. 98).

The jointer is used not only by itself but also in combination with the rolling coulter (Fig. 97). This gives a *combination rolling coulter and jointer*. The rolling coulter cuts the main furrow slice and all trash

vertically from the furrow wall, and the jointer turns its miniature furrow slice as when working alone. The advantage of the combination rolling coulter and jointer is that the rolling coulter cuts all trash and allows the jointer to turn its furrow slice without any trash hanging around the shank. The performance of the plow at high speeds is greatly aided by the rolling coulter and jointer.

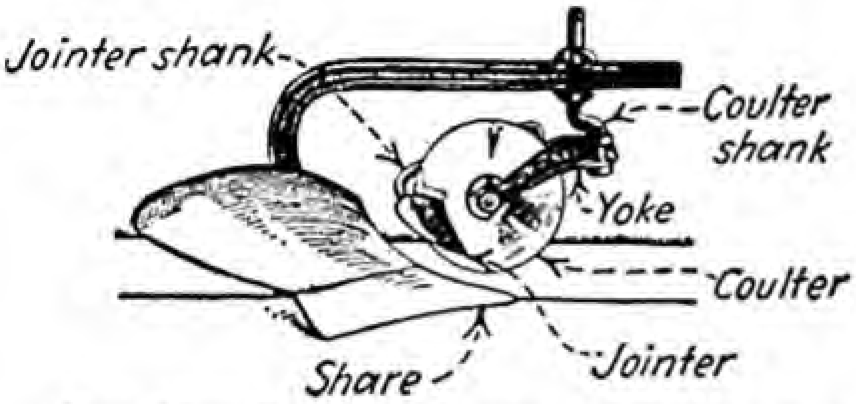


FIG. 97.—Combination rolling coulter and jointer showing how the hub of the coulter is set over the point of the share.

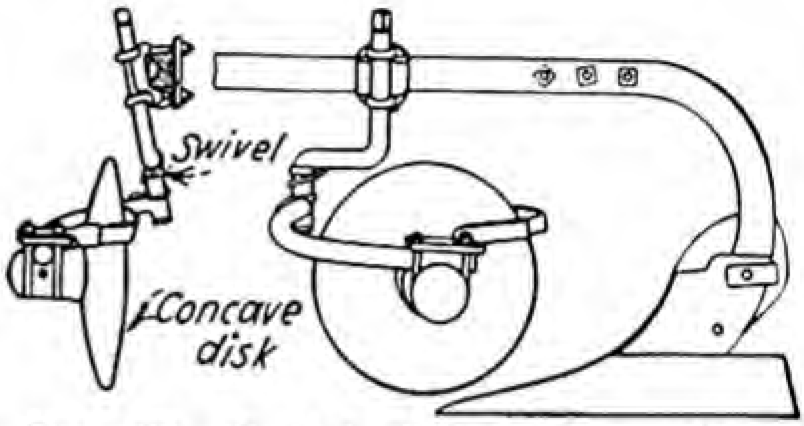


FIG. 98.—Swivel disk jointer. (*U.S. Department of Agriculture.*)

Large notched-blade rolling coulters (Fig. 95) will catch and cut trash better than the smooth-edged rolling coulter. This type of coulter may be more than 2 feet in diameter.

111. Setting Coulters.—There are three essentials to consider in setting any type of coulter: first, the depth at which the best work is done under average conditions. This will depend on the depth of plowing, vegetable matter on the surface, and the physical condition of the soil. Usually 3 to 4 inches deep will meet the requirements of most field conditions.

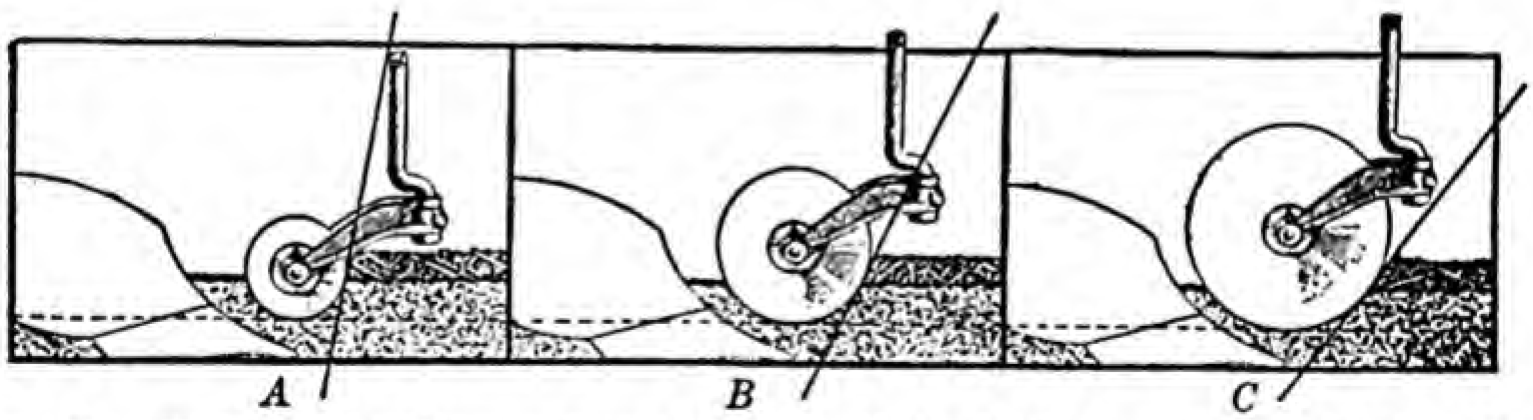


FIG. 99.—The size of rolling coulters influences their ability to mount and cut trash. In *A* and *B* the coulter is too small to mount the trash if it is set deep enough to cut the furrow slice properly. *C* shows the correct setting for size of coulter.

To cut trash thoroughly, the rolling coulter should make a shear cut with the surface of the ground, using the ground as one edge of the shear. That, depending upon the size, limits the depth at which the rolling coulter is set, as shown in Fig. 99. Large rolling coulters are more effective under trashy conditions, as they will mount trash better than small coulters. Notched- or scalloped-edged rolling coulters cut heavy trash better than smooth-edged coulters.

Under average conditions the rolling coulter should be set deep enough to cut trash without clogging and shallow enough to cut trash without riding over part of it. A good rule with large plows is to have the diameter of the coulter equal to or larger than the size of the plow bottom with which it is used. If there are stones, tree roots, or stumps, the coulter should be set ahead of the share point and deep enough to prevent the point of the share from hanging under obstructions.

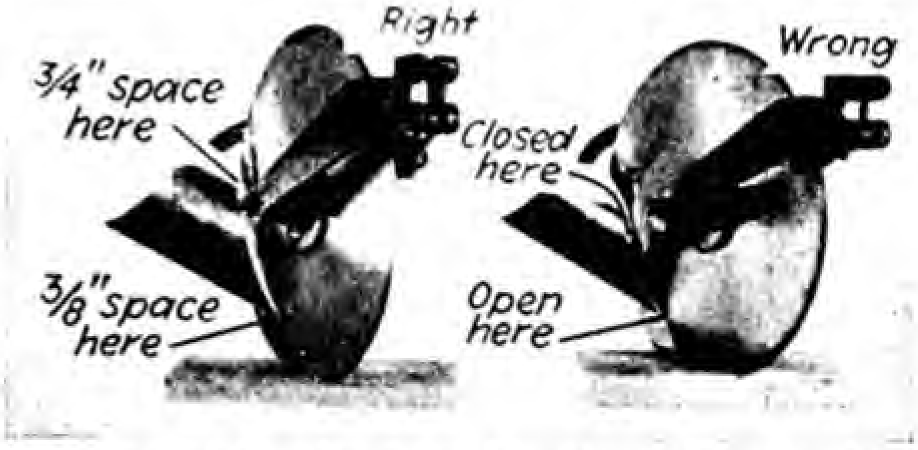


FIG. 100.—Right and wrong way to adjust combination rolling coulter and jointer. (*Ind. Agr. Expt. Sta. Cir.* 217.)

The second point to consider is the horizontal position of the coulter to the shin of the plow. To make the furrow face smooth, the coulter must be set to the left of the shin and deep enough to prevent the shin from digging into the furrow wall. For average conditions, about ½ to ⅝ inch to the left of the shin will be sufficient (Fig. 101), but no set rule can be given.

The third essential is the longitudinal relation of the position of the coulter to the point of the share. For the average plowing job, the rolling coulter should be set so that the center or hub of the coulter will be almost directly above the point of the plow (Fig. 99). If the ground is hard, the coulter should be set high and back of the plow point; otherwise it will affect the penetration of the plow.

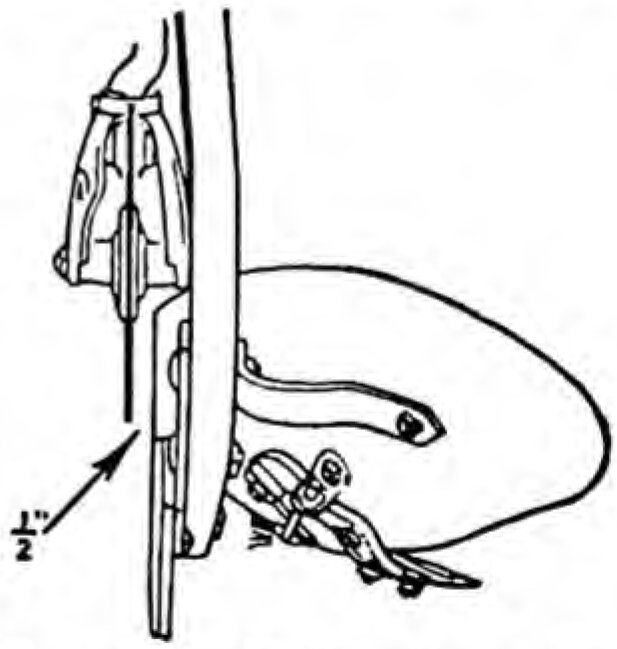


FIG. 101.—Horizontal adjustment for rolling coulter.

If hanging knife coulters are used they should, for most conditions, be set with the points about 1 inch above the point of the share and the whole cutter slanted backward. Where the moldboard jointer is used with the rolling coulter, the former is set so that the heel, which corresponds to the wing of the plow, is just above the surface of the soil. The point of the jointer should fit close up to the side of the rolling coulter but should not bind.

112. Harrow Attachments.—For fall plowing it is usually desirable to leave the soil rough to catch and hold snow and thus collect moisture. Leaving the soil rough will also aid in preventing wind erosion. However, it is usually best to harrow the soil immediately after it has been plowed. Attachments may be secured for this purpose composed of disk, spike, knife, or propeller-like sections. These attachments are never used on the ordinary single-bottom plow but are generally used on the

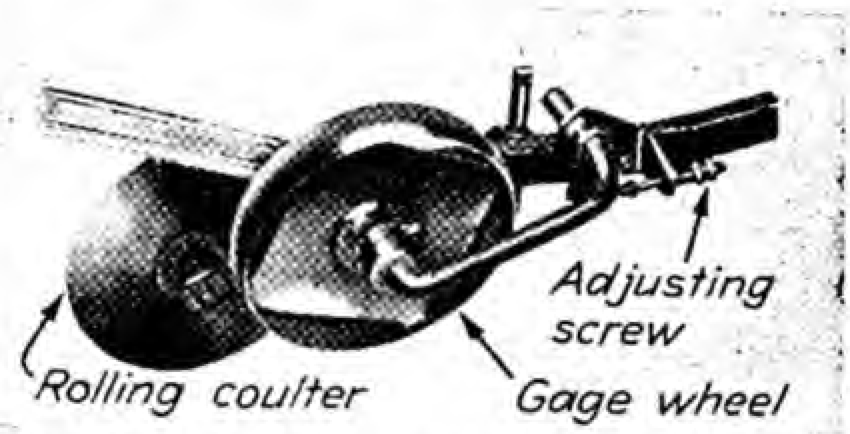


FIG. 102.—Gage wheel to control the depth of plowing.

gang. The attachments are placed to the right and to the rear of the plow and will completely harrow the soil as it is plowed.

113. Gage Wheels.—Gage wheels are attached at the end of the beam near the clevis (Fig. 102) to control the depth of plowing.

114. Weed Hooks, Covering Wires, and Chains.—The common type of weed hook consists of a rod attached to the beam and extending out to the front and side of the plow bottom. The object is to bend the weeds over in such a manner that they will be completely buried in the

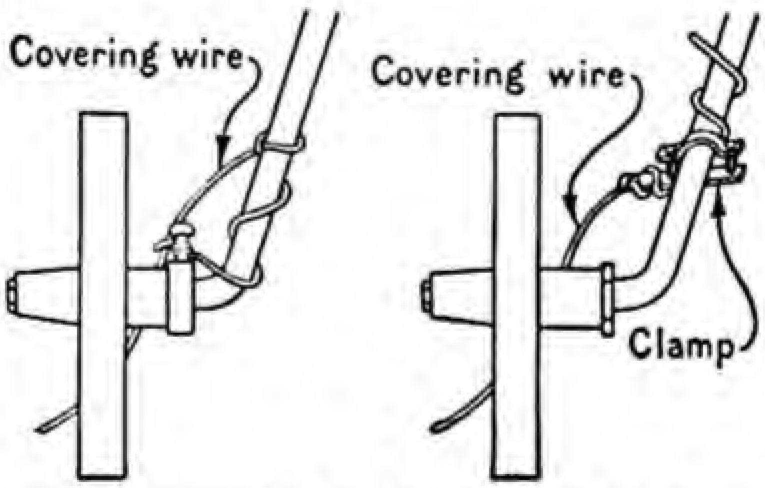


FIG. 103.—Method of fastening covering wires to plow axles. (*U.S. Dept. Agr. Farmer's Bull.* 1690.)

bottom of the furrow. Smooth wires 10 to 12 feet long fastened to the coulter shank and to the axle of the furrow wheel are of much value in covering trash and tall plant growth (Fig. 103). The wires should be rigidly fastened to reduce swinging and dragging under the bottoms when making turns with the plow lifted.

115. Trash Shield for Plows.—The trash shield (Fig. 104) is constructed of sheet metal shaped to form a hood over the top side of the

furrow slice as it is turned over.[1] Trash can be buried deep enough so that it will not interfere with tillage operations. The trash is placed in the bottom of the furrow in the form of a roll, which covers from one-third to

FIG. 104.—The Purdue plow trash shield. (*Ind. Agr. Expt. Station.*)

one-half the width of the furrow. This leaves at least one-half the width of the furrow practically free of trash so that capillary action of soil moisture is not materially affected.

[1] *Ind. Agr. Expt. Sta. Cir.* 217, 1936.

CHAPTER IX

MOLDBOARD-PLOW TYPES

Plow types are divided into two classes, moldboard and disk. In the discussion of plow types it is well to consider the different kinds of plows according to the manner in which they are constructed and operated, either walking or riding, drawn by a team or by mechanical power. Although the manufacturers of farm machinery are placing practically all emphasis on tractor plows and tractor equipment, horse-drawn plows are still extensively used in many sections of the United States and other countries. Therefore, moldboard plows may be divided into two groups, horse-drawn and tractor-operated plows.

HORSE-DRAWN PLOWS

116. The Ordinary Walking Plow.—The walking plow (Fig. 105) was the first type of plow developed to the extent that it was considered a success. Many men worked upon the development of the walking

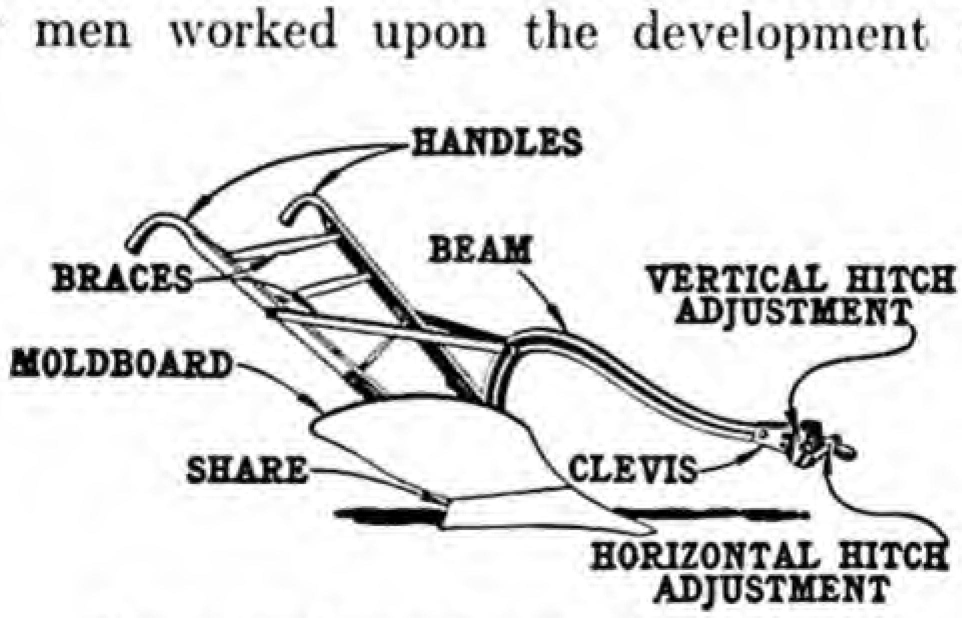


FIG. 105.—Common steel walking plow.

plow, but the steel plow was not developed until near the middle of the eighteenth century. The first successful walking steel plow was invented by John Lane, Sr., in 1833.

Walking plows are referred to according to the material in the bottom as steel, chilled, and, in a few cases, cast iron. The various parts composing the walking plow, such as the share, moldboard, landside, frog, beam, handles, and clevis, already have been discussed. There may be right- or left-hand plows according to the direction in which they throw the furrow slice.

117. Reversible Hillside Plows.—Hillside plows (Fig. 106) consist of walking plows with the moldboard and share hinged at the bottom so they can be reversed either to the right or to the left. The operator is enabled to make a right-hand plow into a left-hand plow by swinging the bottom underneath to the left. They are used in fields where all the furrow slices are to be thrown in the same direction, as on hillsides. from which they get their name. They are good plows for experimental plots and irrigated fields. They are also good for plowing out irregular-shaped fields and in corners. No dead furrow is left when this plow is used.

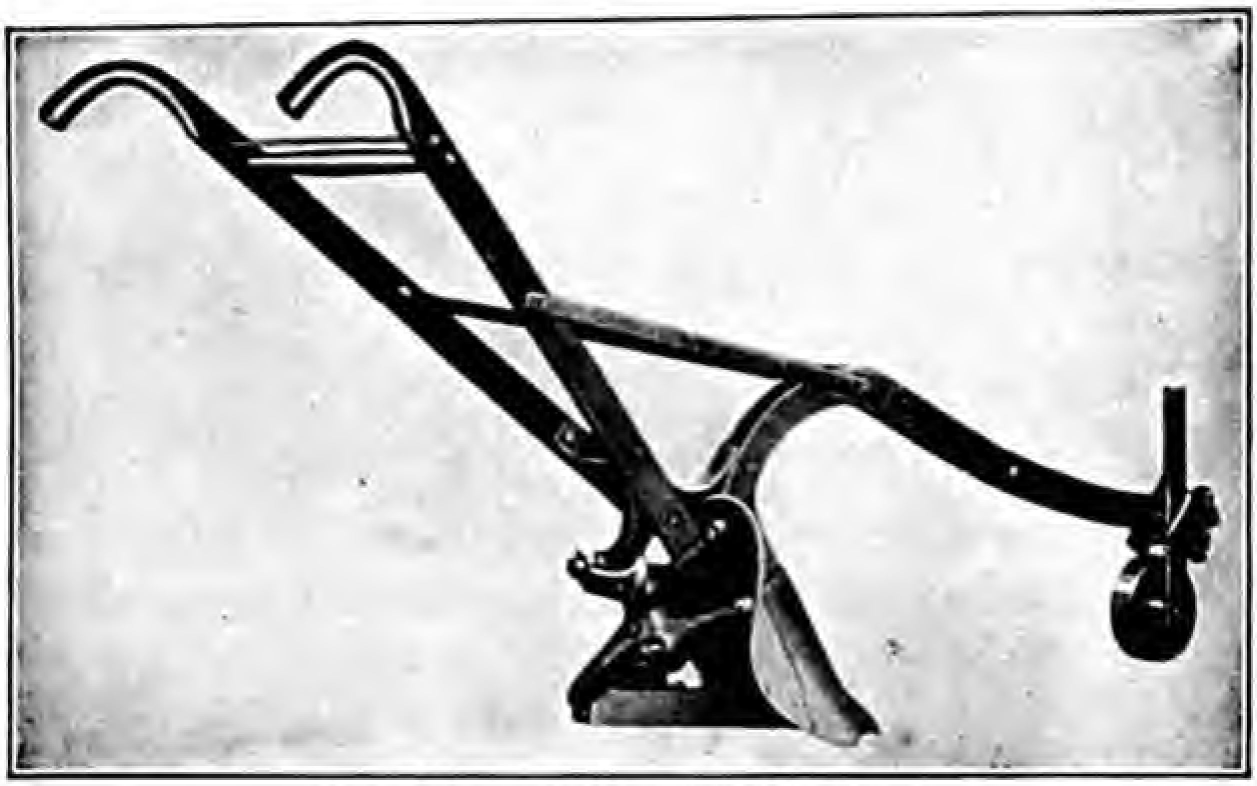


Fig. 106.—Walking hillside plow.

118. Middlebreaker.—This is a special type of walking plow which gets its name from the work it is required to do. In the South, where the middles in between the rows are burst out, it is called a *middlebreaker*. In the semiarid sections of the country, where the crops are planted in the bottom of the furrow, it is called a *lister*. This same tool may be used in an irrigated country for opening up ditches. Here it is called a *ditcher*. However, it is more commonly known as a *middlebreaker*. It is constructed with two moldboards, one for turning the soil to the right, the other for turning it to the left (Fig. 107). The share is double winged to take care of both the right and left boards. This plow, instead of having a landside, has what is called a *rudder;* it acts in about the same way as a landside on an ordinary walking plow. A knife or rudder blade attached to the bottom of the rudder cuts down into the soil and prevents it from dodging to the side. Figure 108 shows the various parts of a middlebreaker bottom.

119. Sulky Plows.—Horse-drawn plows upon which the operator rides are made with one or more bottoms. Such a plow with one bottom is called a *sulky* plow. When composed of more than one bottom it is called

a *gang* plow. The sulky plow may be classified as low lift and high lift. The first successful sulky riding plow was patented by S. F. Davenport in 1864.

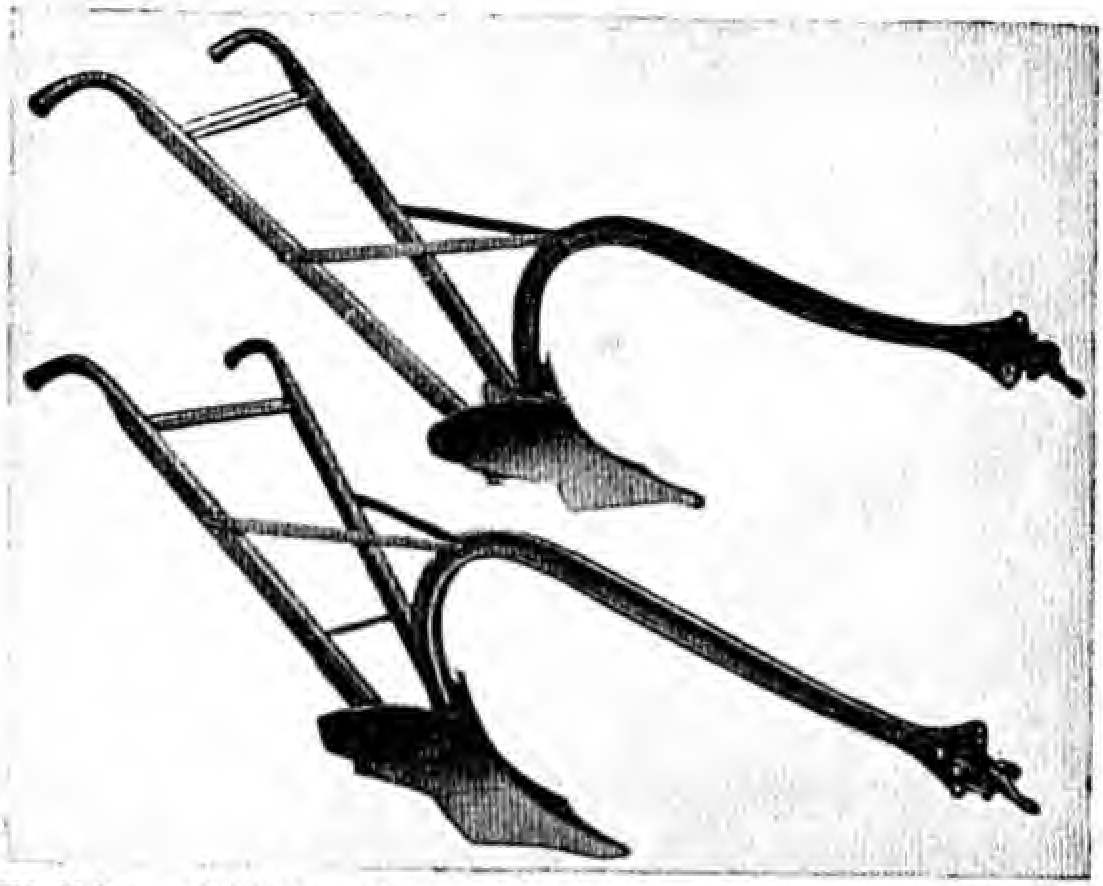


FIG. 107.—Walking middlebreakers. *Above*, sandy type; *below*, blackland type.

The advantages of the sulky plow are (1) friction is reduced because the plow is mounted on wheels; (2) the operator is allowed to ride, afford-

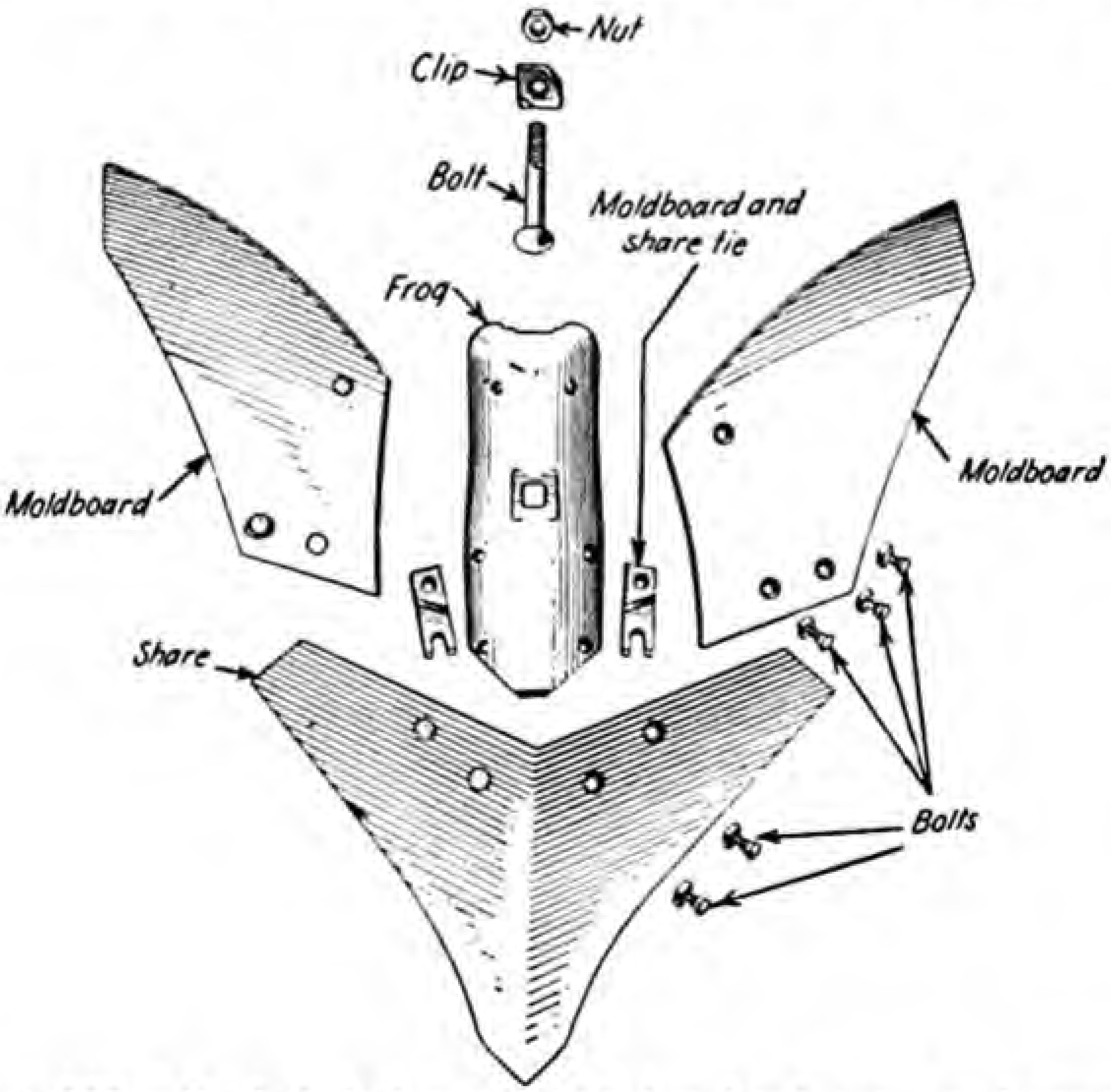


FIG. 108.—Exploded view of middlebreaker bottom and parts.

ing greater ease of operation; (3) with the average unskilled plowman better work will be accomplished because it is steadier and the adjustment cannot be easily disturbed; and (4) there is a tendency to make the

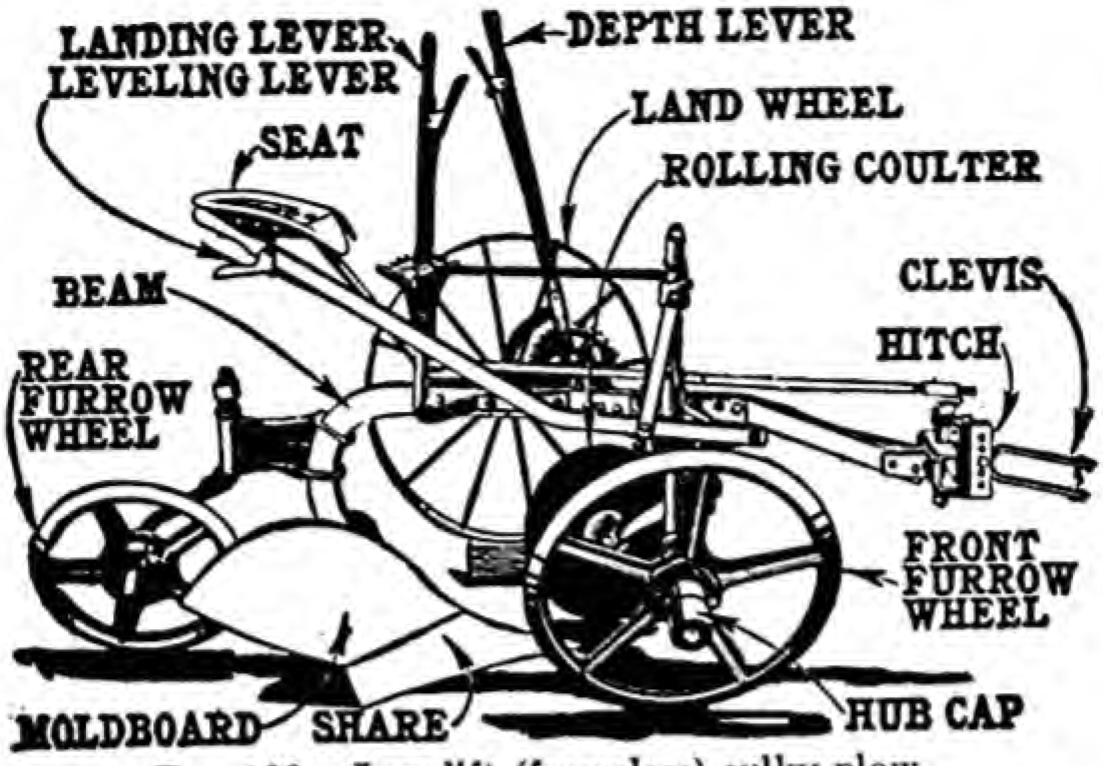


FIG. 109.—Low-lift (frameless) sulky plow.

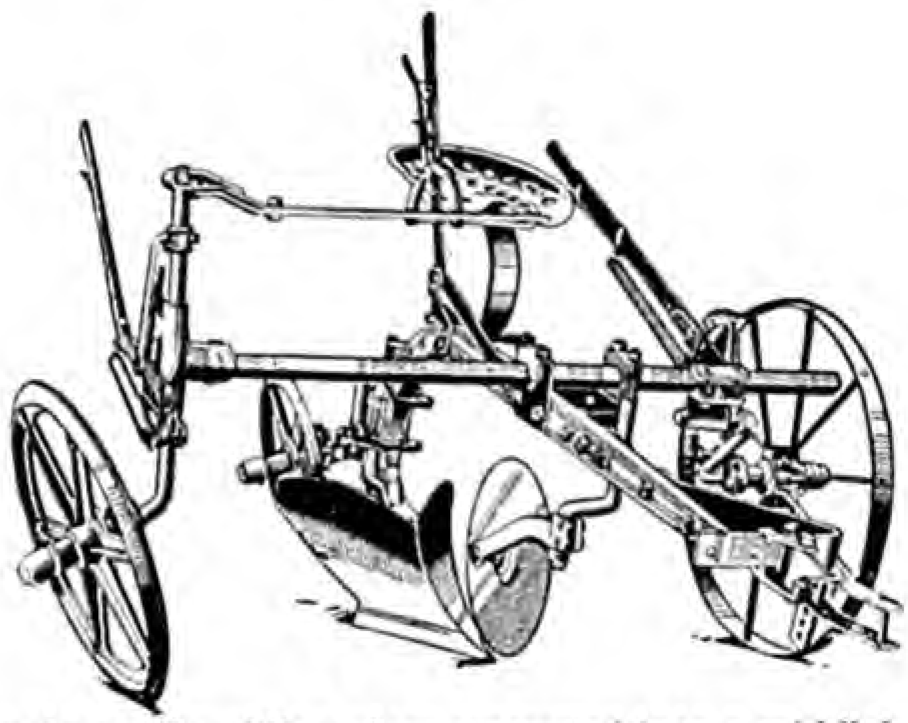


FIG. 110.—Frameless sulky riding plow converted into a middlebreaker or lister.

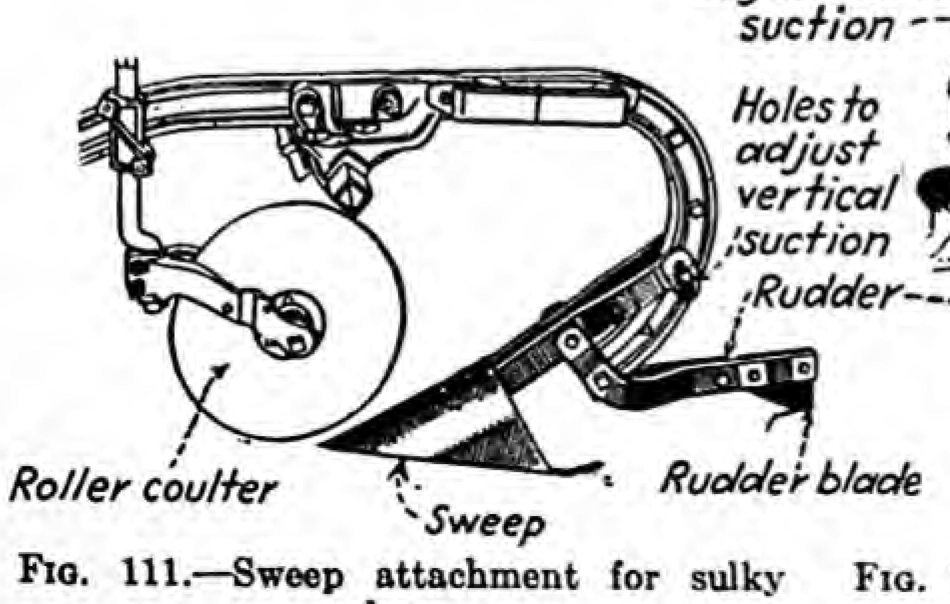


FIG. 111.—Sweep attachment for sulky plows.

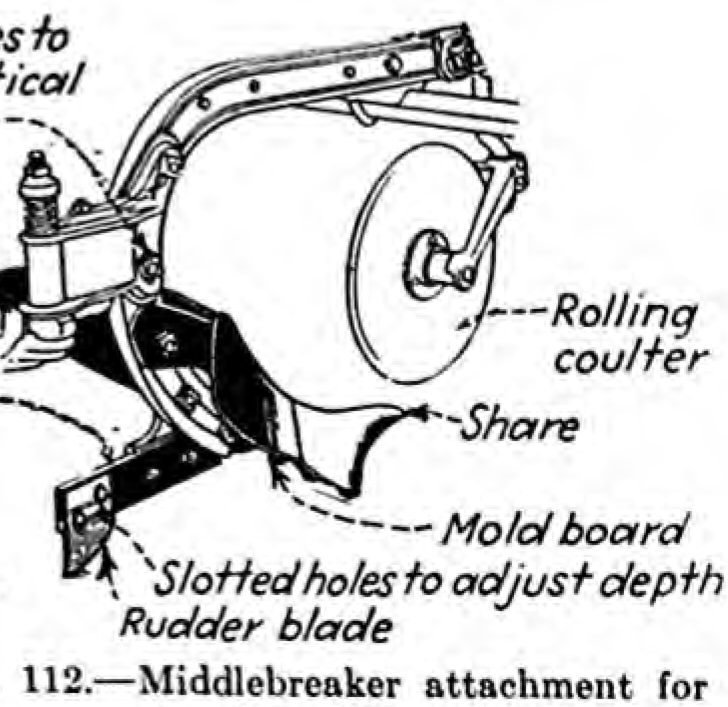


FIG. 112.—Middlebreaker attachment for sulky plows.

plow take the full width of the furrow at all times. The low-lift sulky plow, as shown in Fig. 109, may also be classed as a frameless and a tongueless plow, because it has no frame or tongue.

120. The Riding Middlebreaker or Lister.—The riding middlebreaker Fig. 110) is mounted on a truck of two wheels, having a seat for the operator. There are levers for adjusting the depth. The general construction and use have been discussed under walking middlebreakers.

A special sweep attachment and a middlebreaker attachment for sulky plows are shown in Figs. 111 and 112. Figure 121 shows a three-bottom middlebreaker or lister attachment for a tractor.

TRACTOR PLOWS

The size of farms in all sections of the country varies from a few acres to, in some cases, several thousands of acres. Consequently, the size of the power unit justifiable varies with the number of acres being tilled. This naturally influences the style and size of plow required.

In general, tractor moldboard plows may be grouped into two types, trailing and integral or mounted.

Trailing Plows

The *trailing* or *pull-type* tractor plow is a complete unit in itself, supported by two or three wheels, and when hitched to the drawbar of the tractor it trails behind the tractor. It is built in sizes ranging from one to five bottoms.

121. Single-bottom Plow.—The single-bottom trailing tractor plow (Fig. 113) is balanced on two wheels—a furrow and a land wheel. A

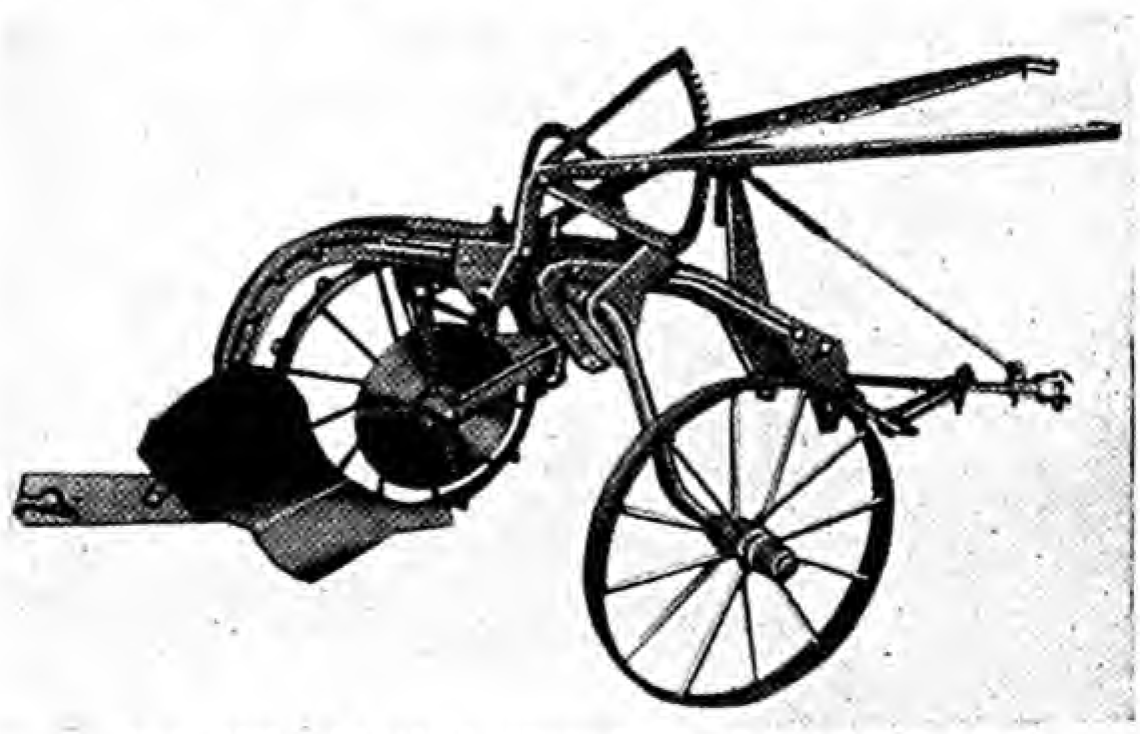


Fig. 113.—Single-bottom trailing tractor plow.

long landside and the hitch hold the plow in position. A power lift is provided in connection with the land wheel. One or two makes of single-bottom plows have a rigidly attached rear furrow wheel.

122. Gang Plows.—Gang plows are plows that have more than one bottom, ranging from two to five (Figs. 114, 115, 116, and 117). The early type of plowing with gang plows was developed in England where a

FIG. 114.—Two-bottom tractor gang plow mounted on two rubber-tired wheels. Note the long landside on the rear bottom.

large steam tractor was stationed at each end of the furrow with a large drum pulley on which a cable was wound. One end of the cable was attached to each tractor drum. The plow was attached to the cable and alternately drawn backward and forward across the field by the

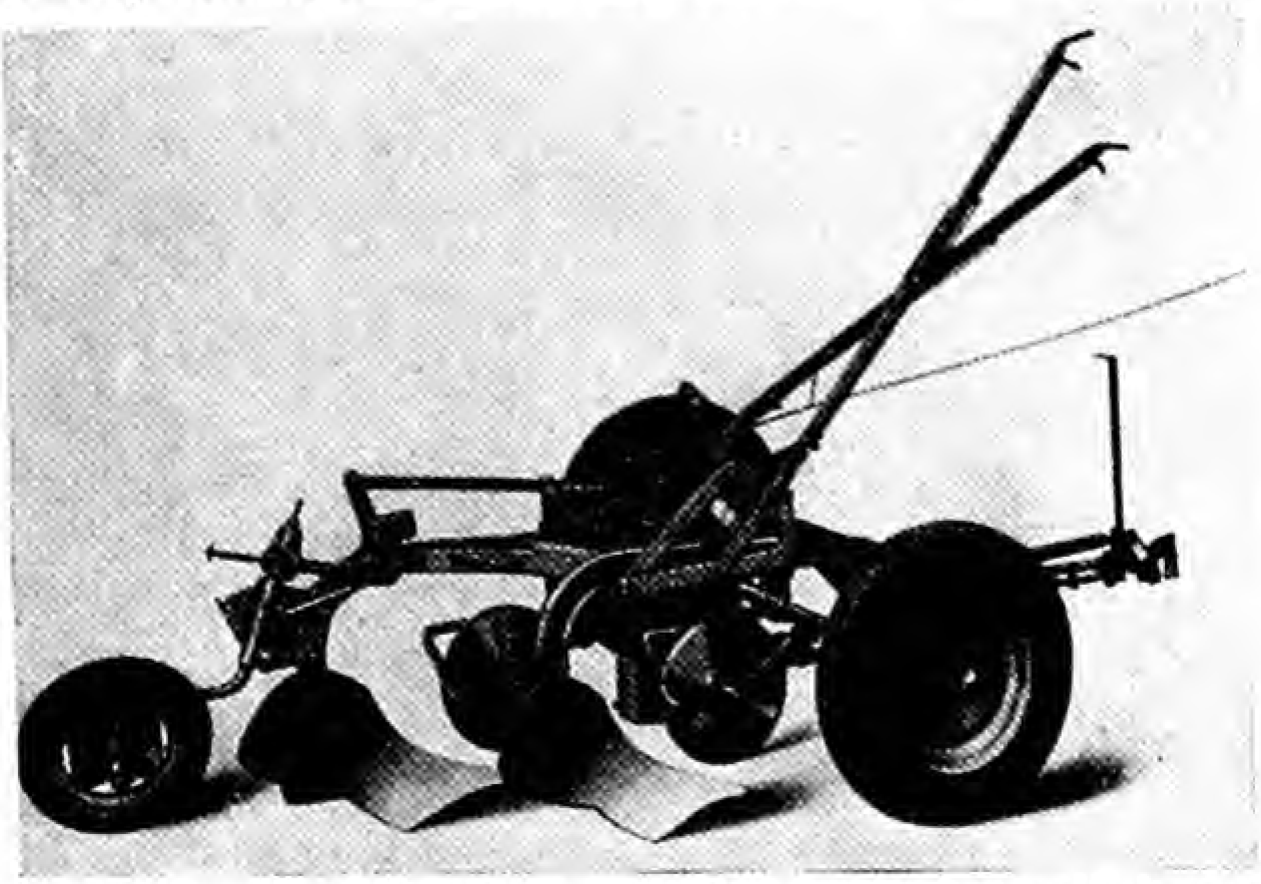


FIG. 115.—Two-bottom trailing tractor plow equipped with pneumatic tires on all three wheels.

tractors. The American idea is to hitch the plow behind the power and move tractor, plow, and all across the field together.

Some two-bottom plows are not provided with rear furrow wheels (Fig. 114), but all plows with three or more bottoms have a rear furrow

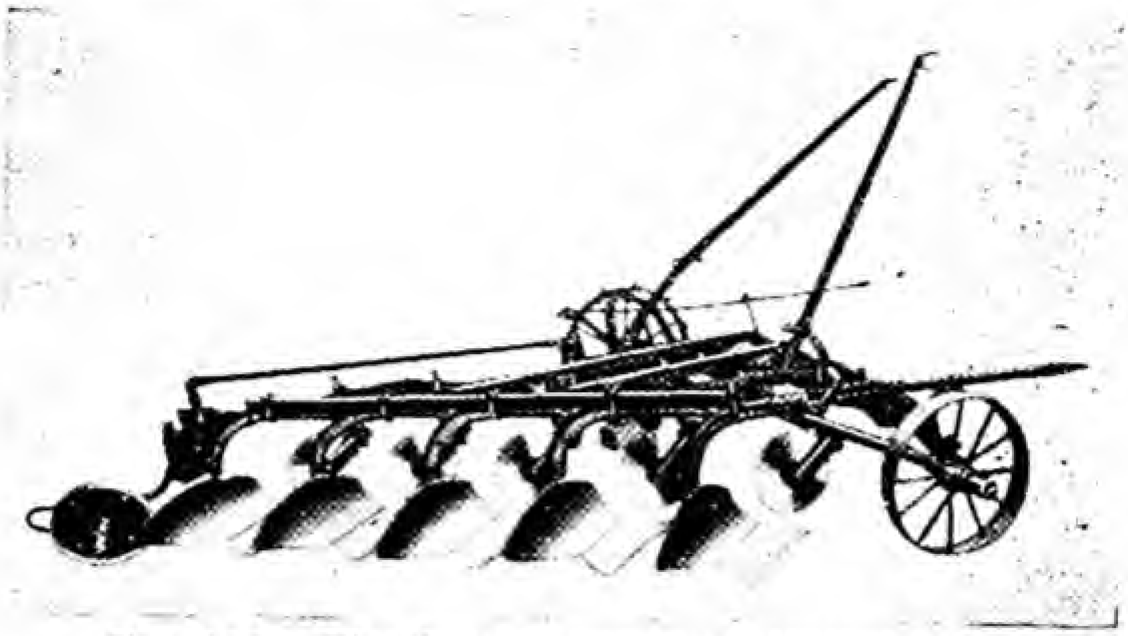


FIG. 116.—Five-bottom power-lift tractor plow.

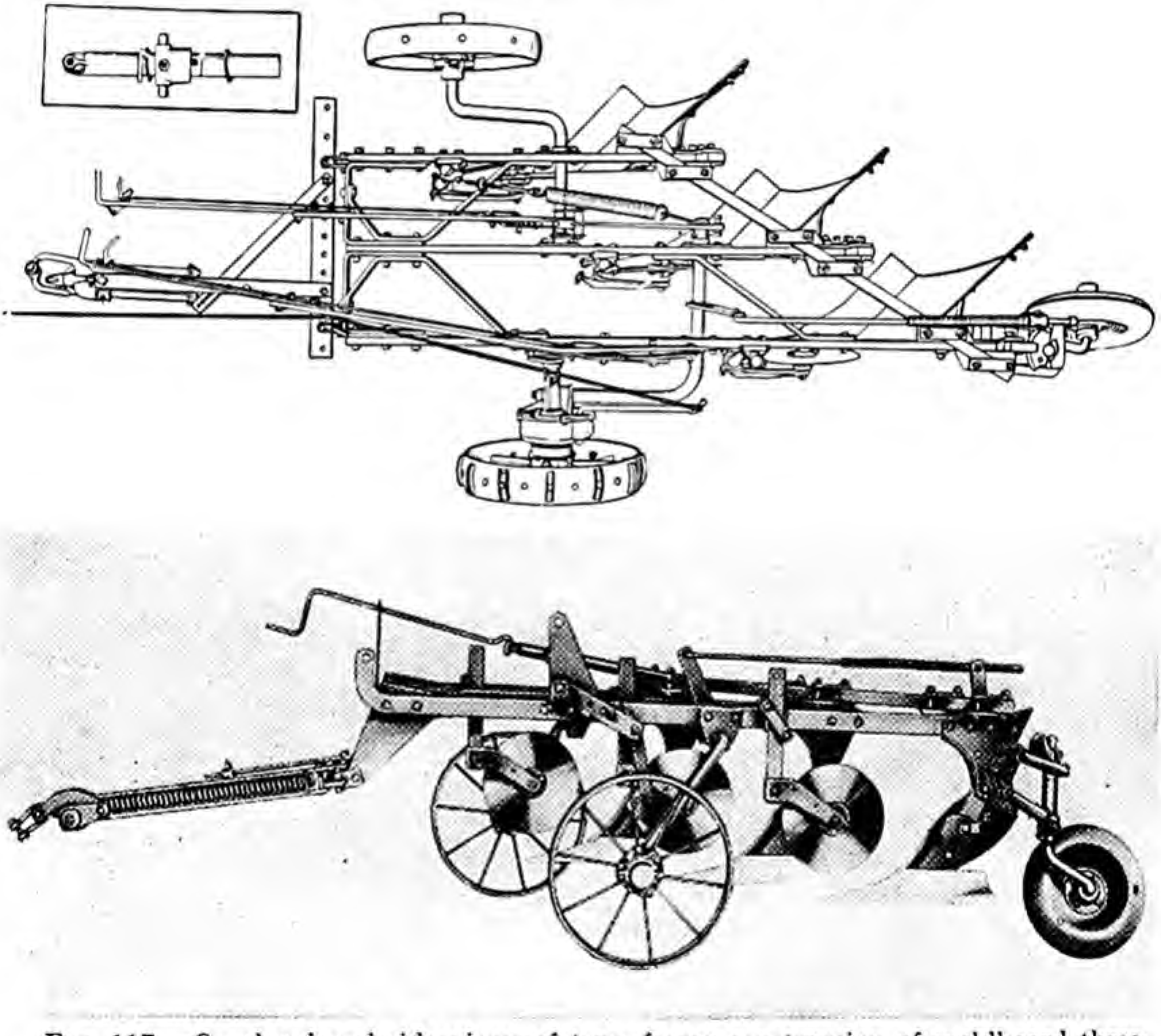


FIG. 117.—Overhead and side views of truss-frame construction of moldboard three-bottom tractor plow. A two-way hydraulic cylinder can be attached for lifting and controlling depth of plowing.

wheel. A power lift (Fig. 118*a*) built into the hub of the land wheel raises the plow as a unit. The tractor operator raises and lowers the plow bottoms on all three wheels by pulling a rope which causes the clutch to engage; the power of the tractor pulling the plow forward will

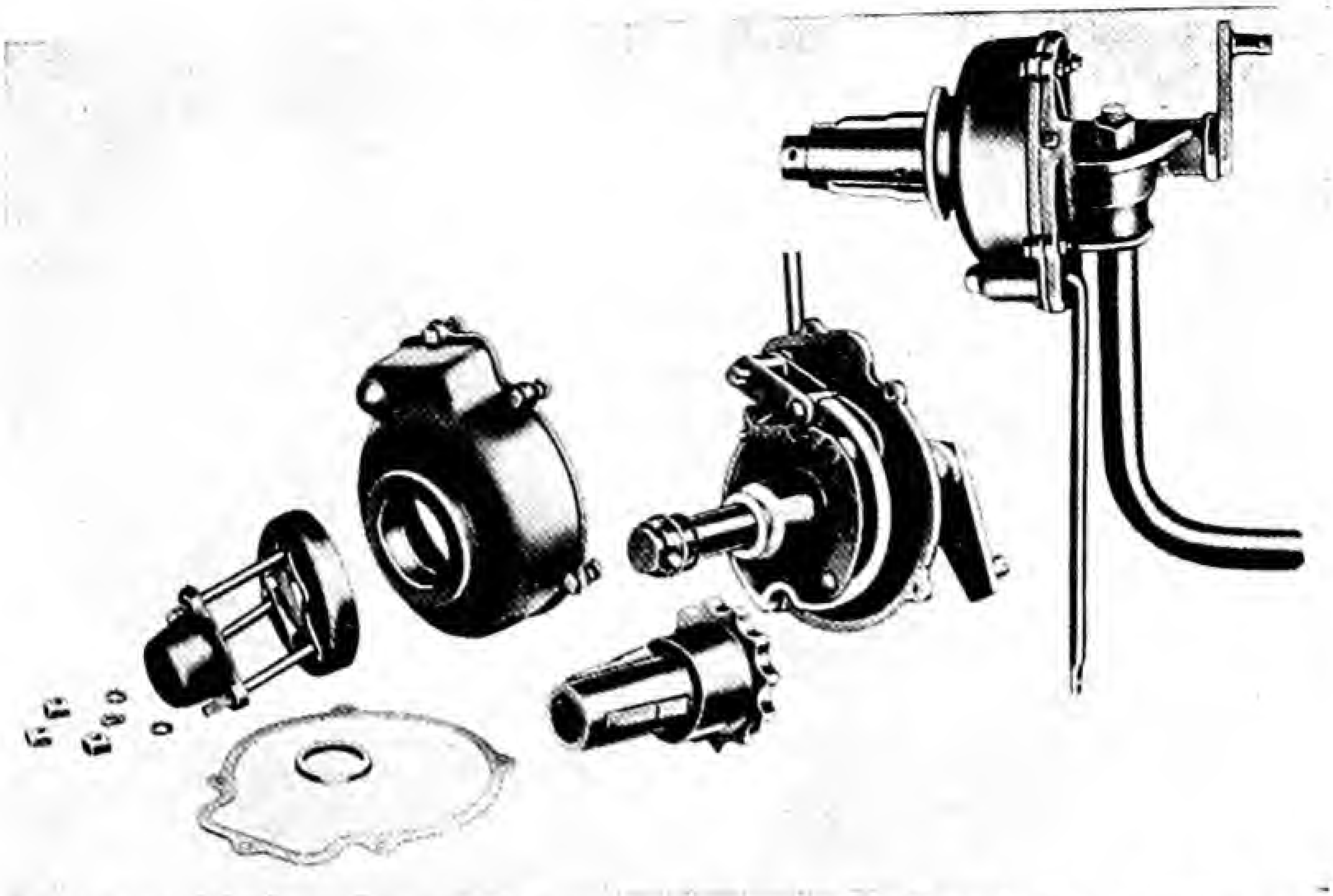


FIG. 118a.—Enclosed power lift assembled and "exploded" to show various parts.

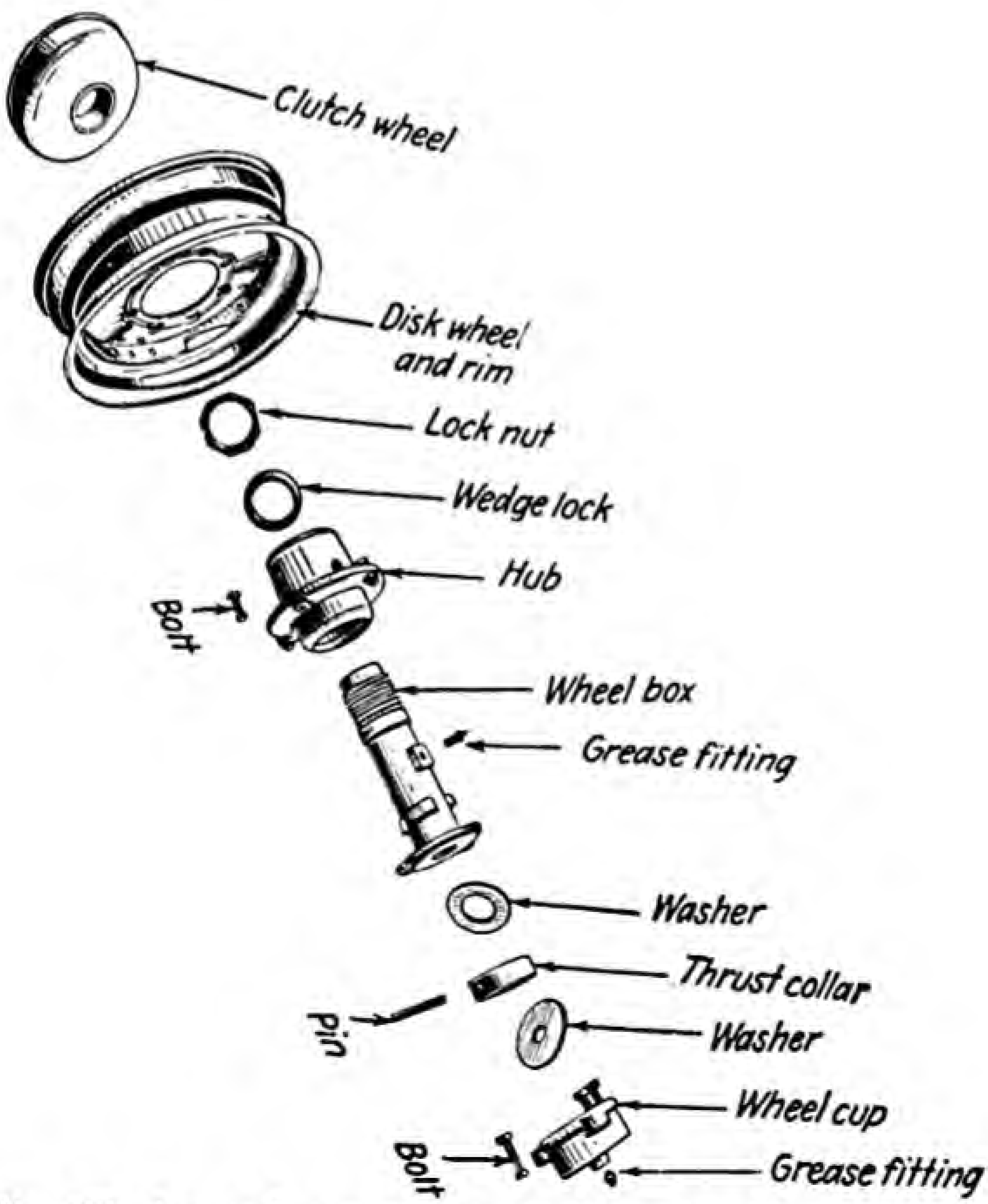


FIG. 118b.—Wheel parts for pneumatic tire for land and furrow wheel of plow.

raise it out of the ground. The plow is lowered into the soil by the operator pulling the rope, releasing the clutch, and allowing the plow to drop on the ground. Then as the tractor pulls it forward, the down suction of the bottoms causes them to enter the soil.

The tractor operator can control both the tractor and the plow when this type of plow is used. The land wheel runs vertically and straight forward. The front furrow wheel on some plows is set at an angle, while on others it runs almost vertically and straight forward. The rear furrow wheel is set similar to that on the horse gang. It is sometimes given a lead away from the furrow wall, while in other cases it is allowed to run straight to the front. Depth levers are provided for regulating

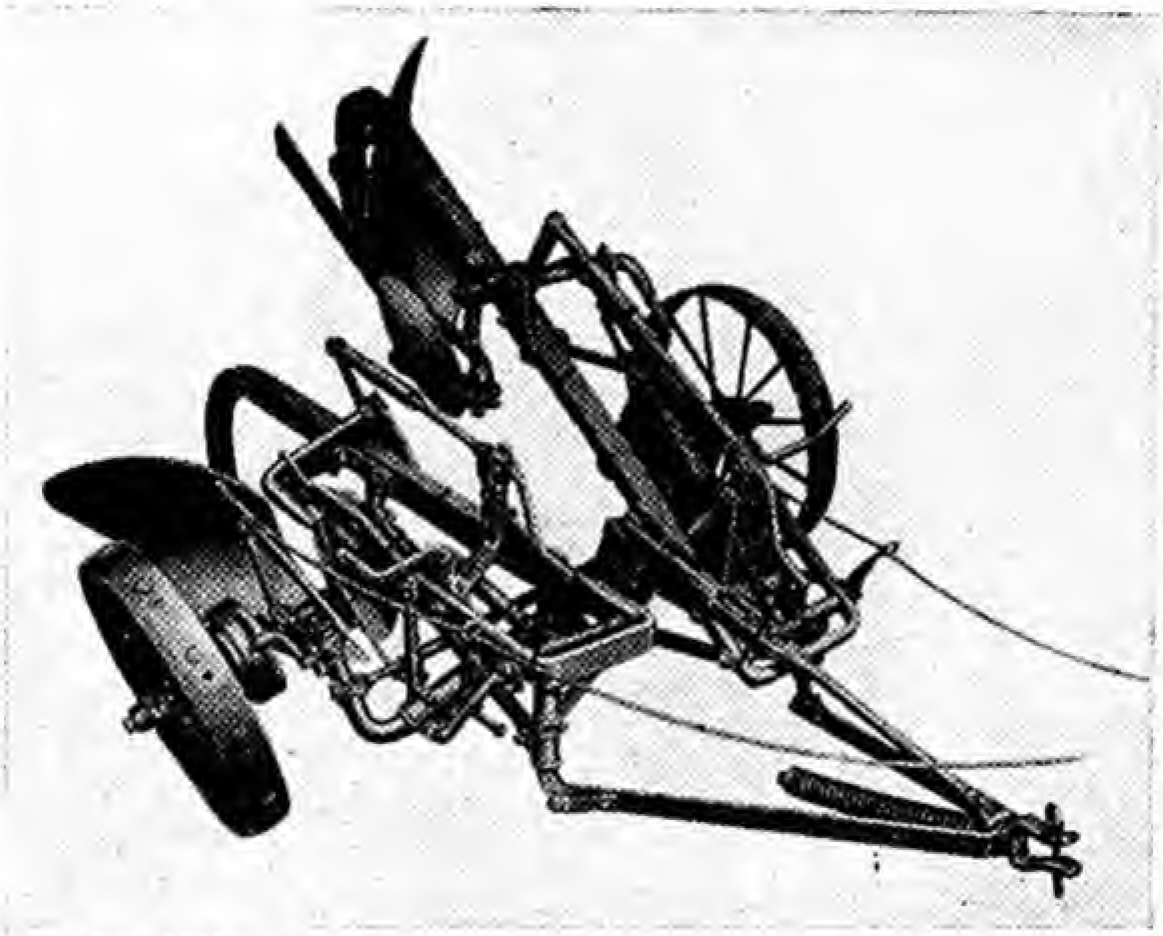


FIG. 119.—Two-way single-furrow tractor-drawn plow.

the depth of the plows and also for leveling them. The clutches found on this type of plow are exactly like those found on check-row planters except that they are much larger and stronger. They are of the ratchet and pawl type. All the tractor plows are guided and controlled by the tractor. The hitch and various adjustments will be discussed under another heading. Pneumatic tires can be obtained for many plows when desired (Figs. 114 and 115).

123. Two-way Tractor-drawn Plows.—The plows shown in Figs. 119 and 120 are tractor plows having both right- and left-hand bottoms. The right-hand bottoms are used while going in one direction and the left-hand bottoms are used when going in the opposite direction. This type of plow is used in irrigated sections and where the land is to be broken without leaving dead furrows. It also can be used on terraced fields.

There are two types of tractor-drawn two-way plows, the power-lift

and the "roll-over" or jump plow. Figure 119 shows the single-furrow power-lift plow with one bottom raised There is a power-lift clutch on each wheel. By pulling ropes attached to each clutch either or both bottoms can be raised.

The plow shown in Fig. 120 rolls over when a clutch is tripped by pulling the trip rope. When the plow is completely reversed it automatically catches and is locked in position.

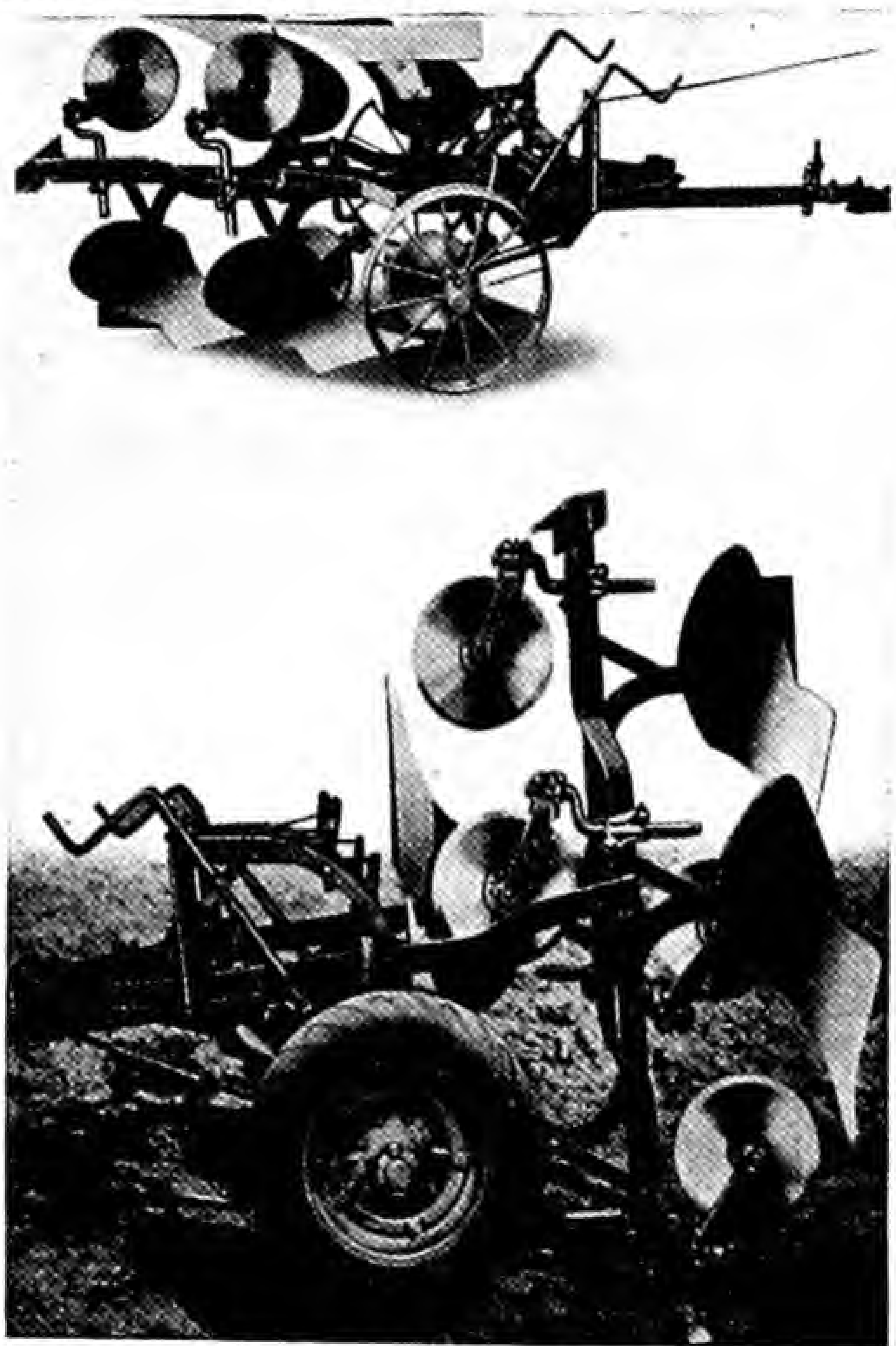


FIG. 120.—Two-furrow two-way "roll-over" plow. Inset shows plow halfway in roll-over reversing operation.

124. Tractor-drawn Listers.—The tractor-drawn lister has been largely supplanted by the tractor-mounted or tool-bar lister. The three-row lister shown in Fig. 121 is equipped with power lift and lever-controlled gage wheels. The two outside bottoms can be moved in or out at intervals of 2 inches to give five different row spacings, ranging from 36 to 44 inches. The gage wheels also can be moved along the long hub to fit different row spacings.

125. Basin or Damming Lister.—In areas where the soil has a tendency to blow and soil moisture is low, dams are made in the listed furrow

with a damming attachment to form basins in which rainfall is stored (Fig. 122). The water collected in the basins soaks into the soil (Fig. 123), providing moisture for crops, preventing soil and water losses by

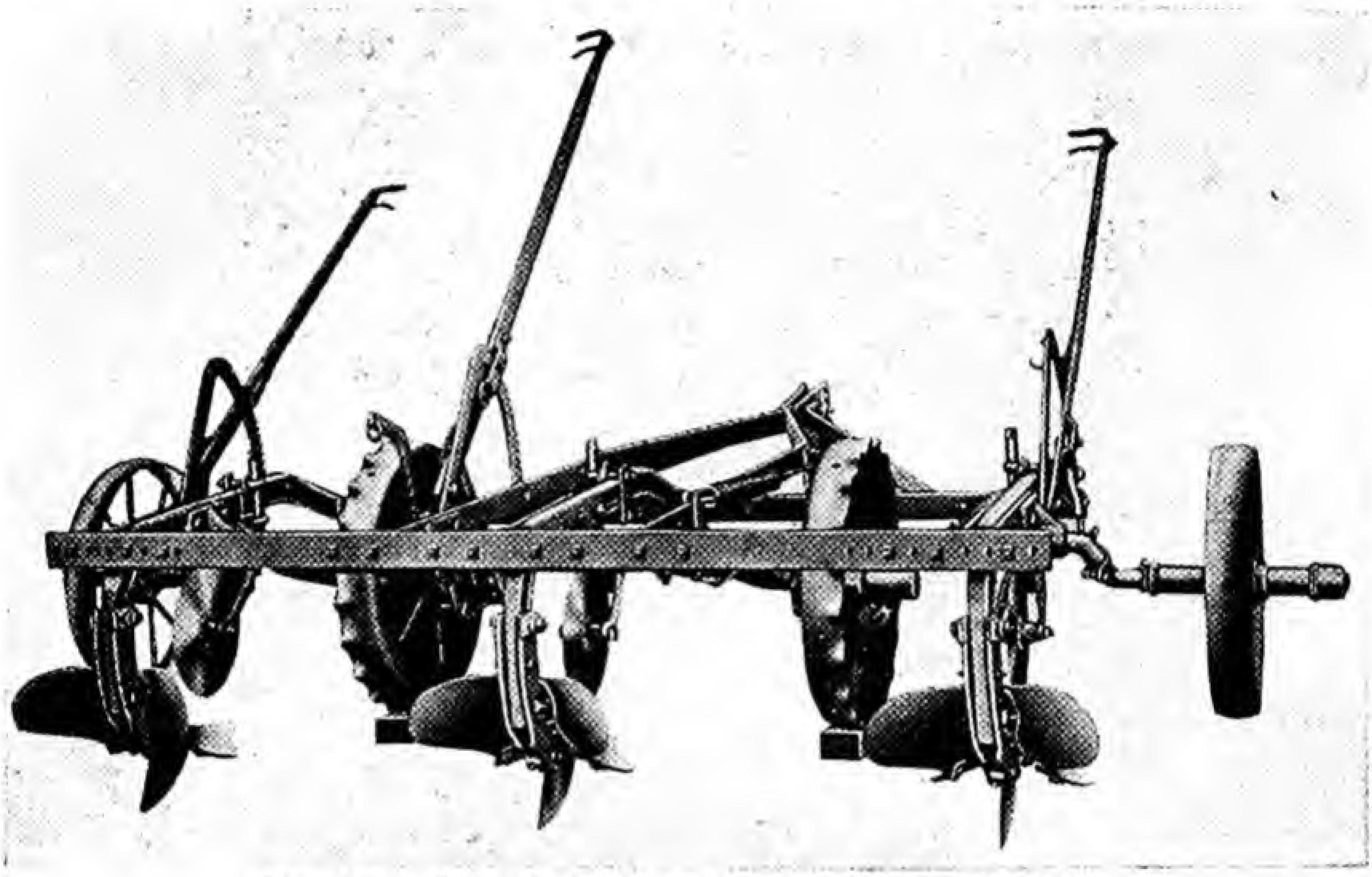


FIG. 121.—Three-bottom tractor-drawn power-lift lister.

erosion, and aiding in checking wind erosion. The dams are formed with blades shaped to fit into a listed furrow so they will catch soil on the sides and bottom of the furrow.

FIG. 122.—Tractor pulling a four-furrow lister equipped with damming attachments.

When the blade has moved forward 8 or 10 feet, or enough to fill the furrow with soil, the pressure of the soil actuates a trip which releases

FIG. 123.—Illustrating how dams in lister furrows form basins to hold water.

the blade, and the entire assembly revolves over the dam back into position for the next dam (Fig. 124).

FIG. 124.—Simple damming attachment for basin listing.

126. Draft of Basin Attachments.—Tests made at the Fort Hays Branch of the Kansas Agricultural Experiment Station with a two-bottom lister equipped with a basin attachment showed that the attachment increased the draft approximately 10 per cent. The draft of the two lister bottoms with the basin attachment on was 1,520 pounds, requiring 10.2 horsepower. With the basin attachment left off, the two lister bottoms gave a draft of 1,224 pounds, requiring 8.2 horsepower to draw the bottoms.

127. Subsoiling Plows.—Some types of soils have rather hard impervious subsoils which, when broken, aid in moisture conservation and root penetration. A single-standard subsoiler is shown in Fig. 125. Figure

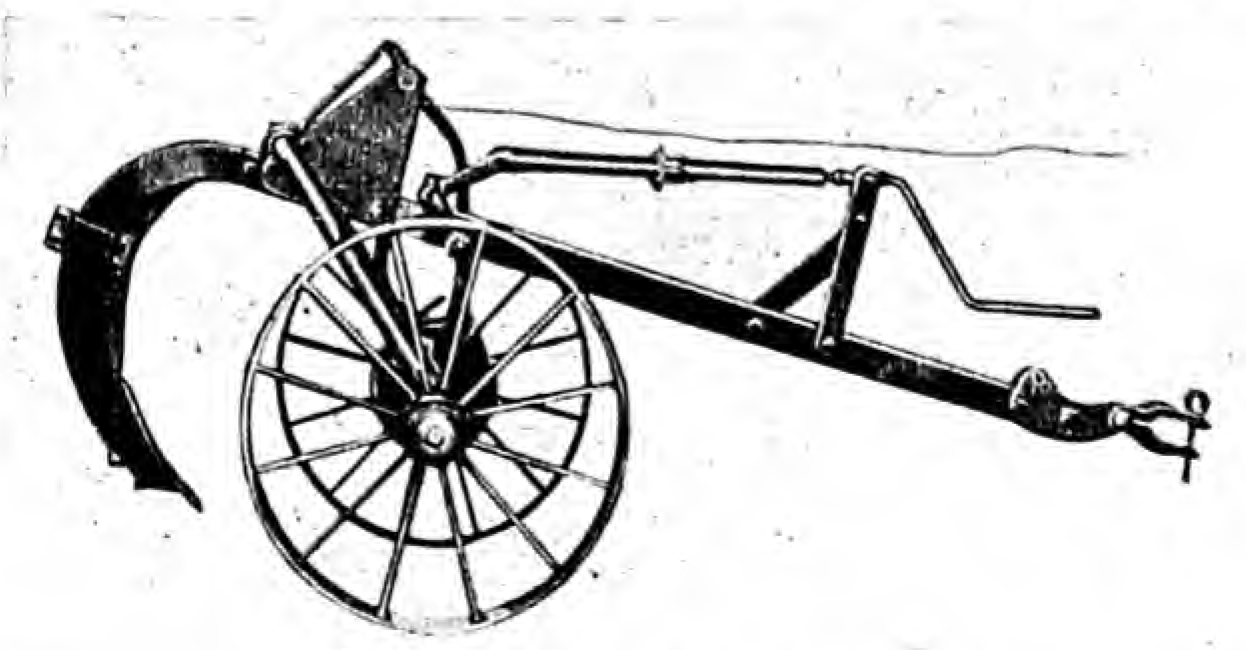


FIG. 125.—Power-lift subsoil plow.

126 shows a general-purpose tractor with two subsoil standards attached to the tool bar. When deep penetration is desired extra-heavy equip-

FIG. 126.—One or more subsoil standards can be attached to tool bar.

ment is required. Figure 127 shows a regular two-bottom tractor plow equipped with small subsoiling bottoms. The subsoil bottoms are placed directly behind the regular bottoms so they will plow 2 to 4 inches deep

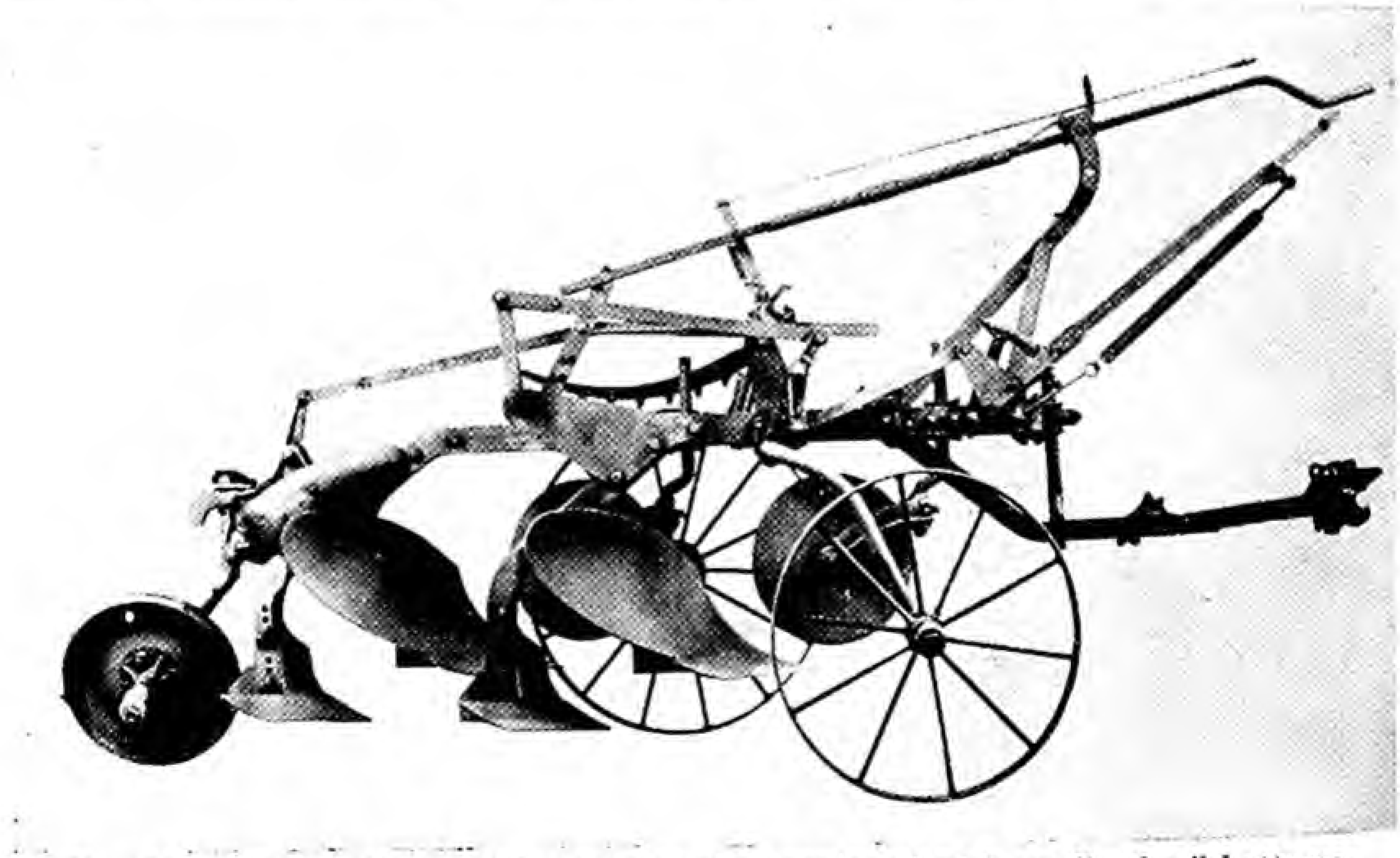


FIG. 127.—Two-bottom trailing tractor plow equipped with small subsoil bottoms.

in the bottom of the main furrow, loosening the subsoil but not turning it up on the surface.

128. Chisel Plow.—Figure 128 shows a special type of tool called a *chisel* plow. It is claimed that it stirs the soil thoroughly without turning up the moist subsoil, thus leaving the dry soil on top; that it gives deep cultivation, breaking up hardpans and plow soles, which permits

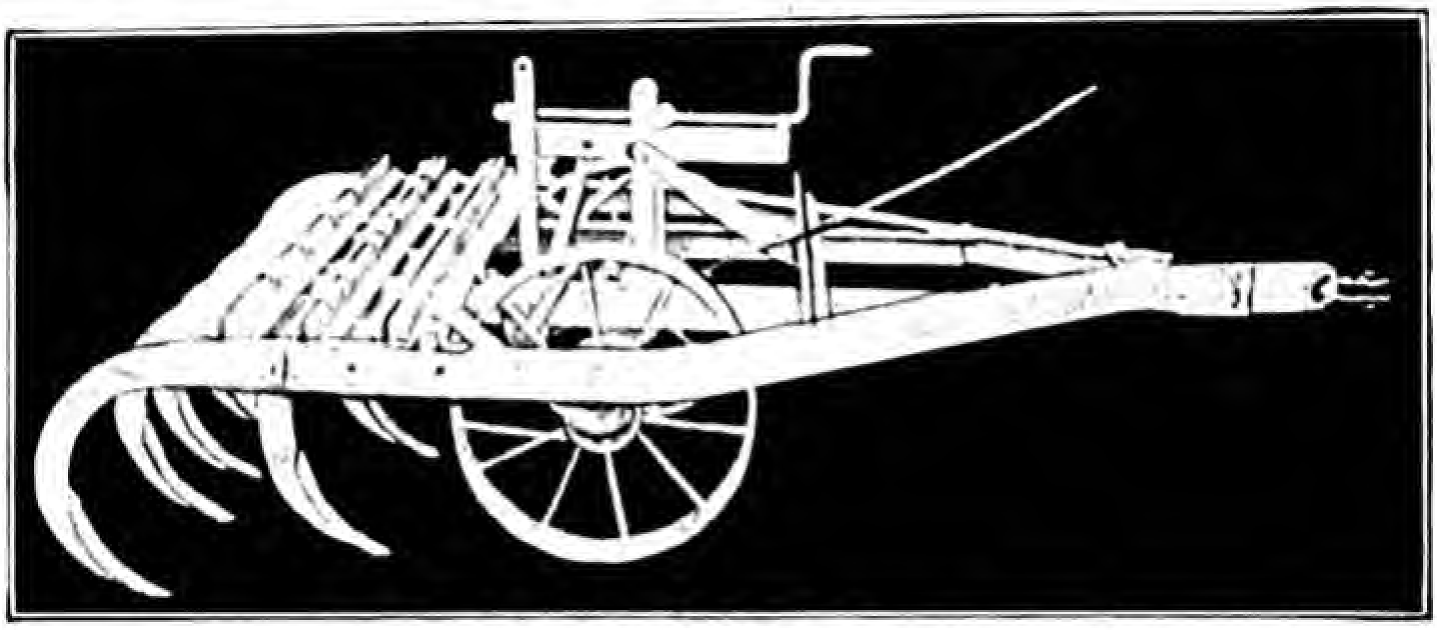


FIG. 128.—Chisel plow.

free movement of soil moisture and the absorption of a larger percentage of rainfall.

129. Brush Plow.—The plow shown in Fig. 129 is equipped with an 18-inch-bottom, extra-large, heavy coulter and is suitable for turning under underbrush. It is designed to plow as deep as 12 to 16 inches.

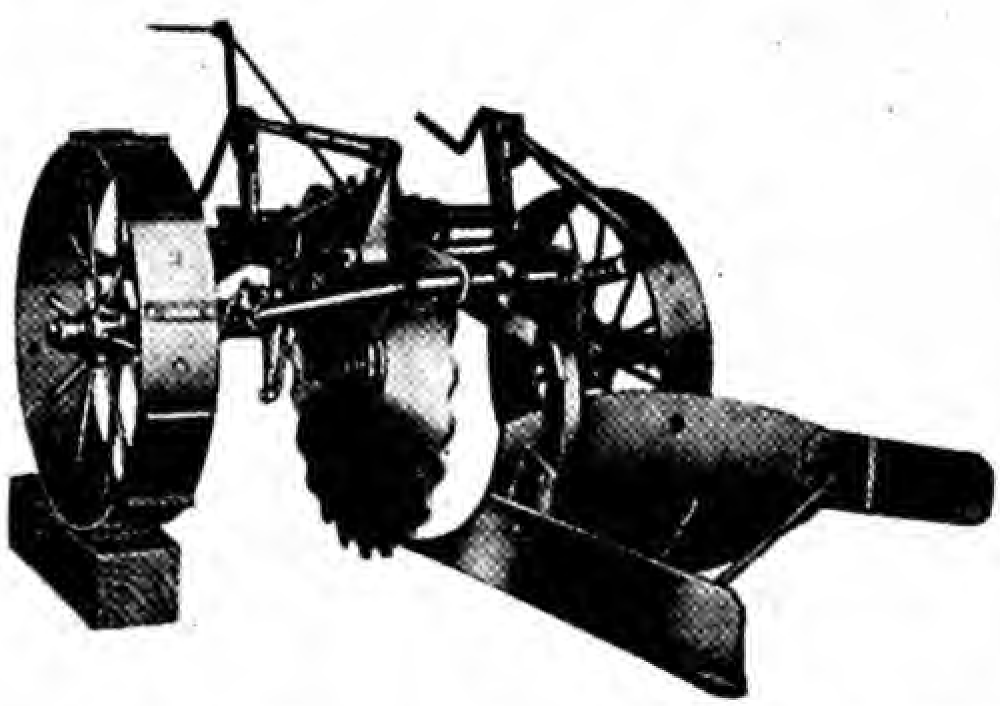


FIG. 129.—Heavy single-bottom plow for breaking brushland.

130. Sugar-cane Plow.—Figure 130 shows a plow built especially for bedding of land where sugar cane is grown. Note that there are two middlebreaker bottoms, one at the front and one at the rear. There are also two moldboard bottoms, a right- and a left-hand bottom. The front middlebreaker bottom is adjusted so that it will clean off the top of the bed. The large 22-inch rolling coulter in front of the leading breaker bottom should be set well below the point of the share so that it will

more positively cut through plant residue. The side 10-inch right- and left-hand bottoms are equipped with 18-inch coulters. The rear middlebreaker bottom, equipped with an 18-inch coulter, breaks out the strip

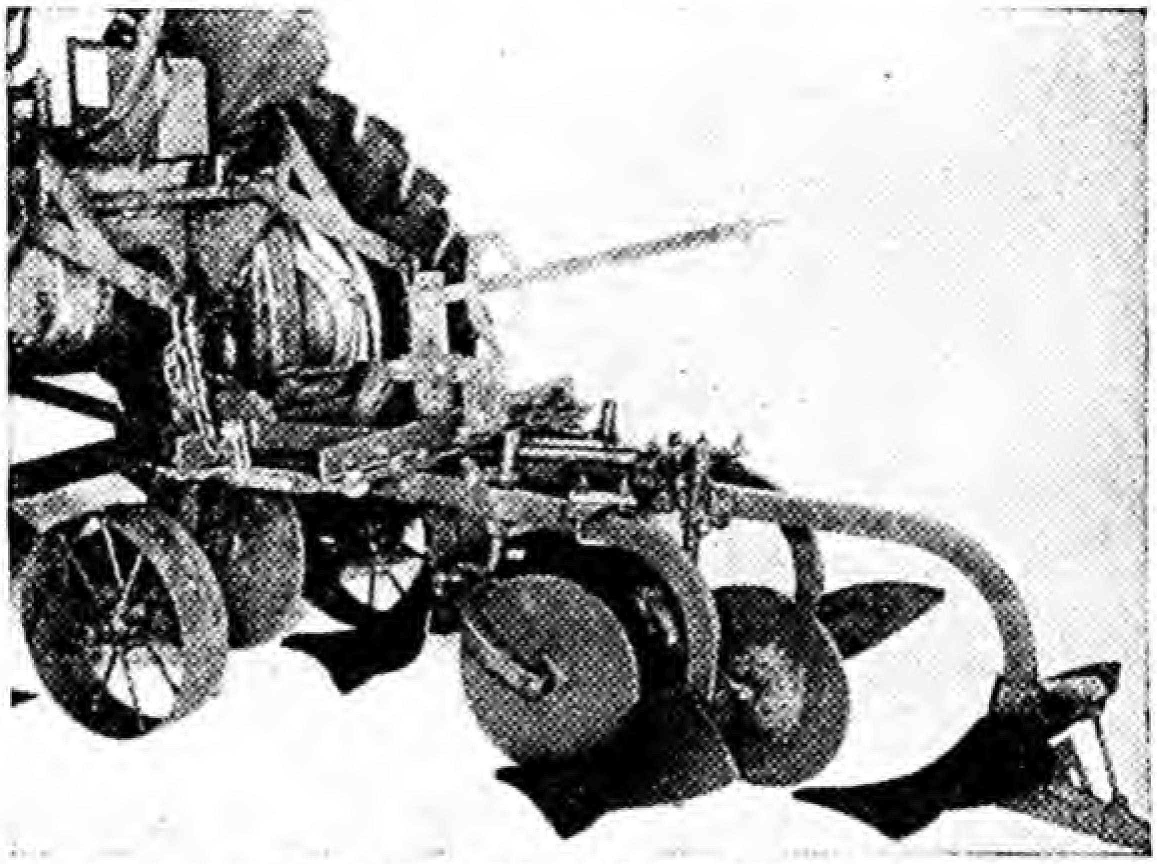


FIG. 130.—Plow for the bedding of land for sugar cane.

of soil left unbroken by the side bottoms deeper than the front breaker bottom. The plow is lifted by hydraulic power from the tractor.

For barring off stubble the front and rear middlebreaker bottoms are taken off the plow (Fig. 131).

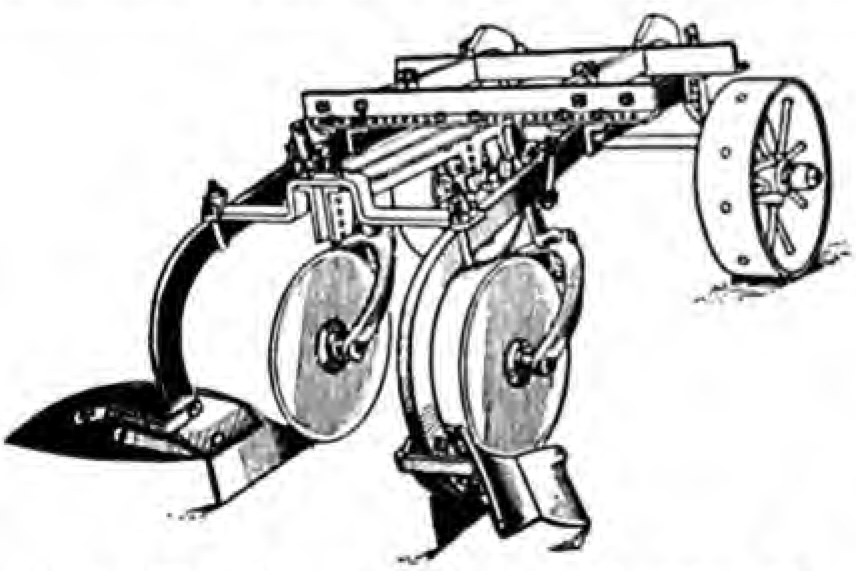


FIG. 131.—Cane plow set for barring off.

INTEGRAL-MOUNTED PLOWS

This type of plow also is called a *direct-connected*, *tractor-mounted*, or *tractor-carried* plow. The plow is really a tractor attachment, as it depends upon the tractor for its power lift and the power of the tractor engine for its general operation. The entire weight of the plow is carried on the tractor when lifted. The depth of plowing is controlled in some cases hydraulically, in others by levers and gage wheels. At present not more than two bottoms are mounted on the tractor. This is because integral-mounted plows are used only on the small and medium-sized tractors. With the right wheel of the tractor running in the furrow, the center of the load and horizontal line of draft falls almost directly behind the center of the power (Fig. 134).

131. Single-bottom Plows.—Single-bottom integral-mounted plows are used mostly on small tractors. The smallest tractor of 8 to 10

FIG. 132.—"Baby" tractor equipped with integral-mounted moldboard plow.

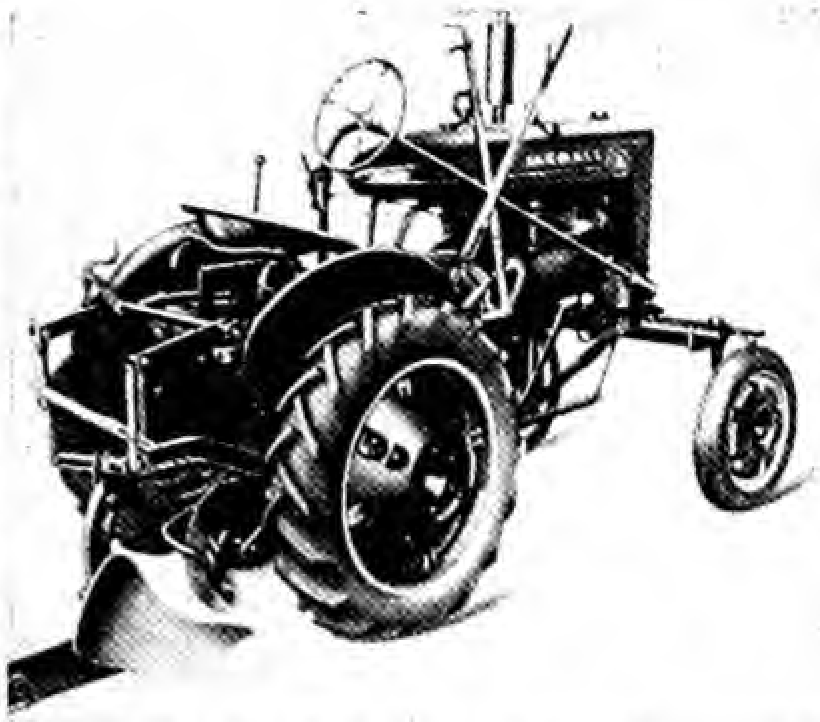


FIG. 133.—Single-bottom integral-mounted tractor plow for small tractor.

drawbar horsepower is equipped with a 12-inch bottom (Fig. 132). Other small tractors use 14-inch bottoms (Fig. 133). In most cases, the plows are equipped with long landsides to steady the plow, and coulters and jointers may be used. Generally the beam extends forward under the tractor and is attached well forward on the tractor. Some plows of this type are lifted and held in the soil at a uniform depth by a hydraulic "touch control system."

132. Two-bottom Plows.—The two-bottom integral-mounted plows (Fig. 134) are attached to the tractor in much the same manner as the single-bottom integral-mounted plows. The principal difference is that the former has two beams and bottoms while the latter has only one. It is obvious that it requires more power to operate two bottoms than it does to operate one.

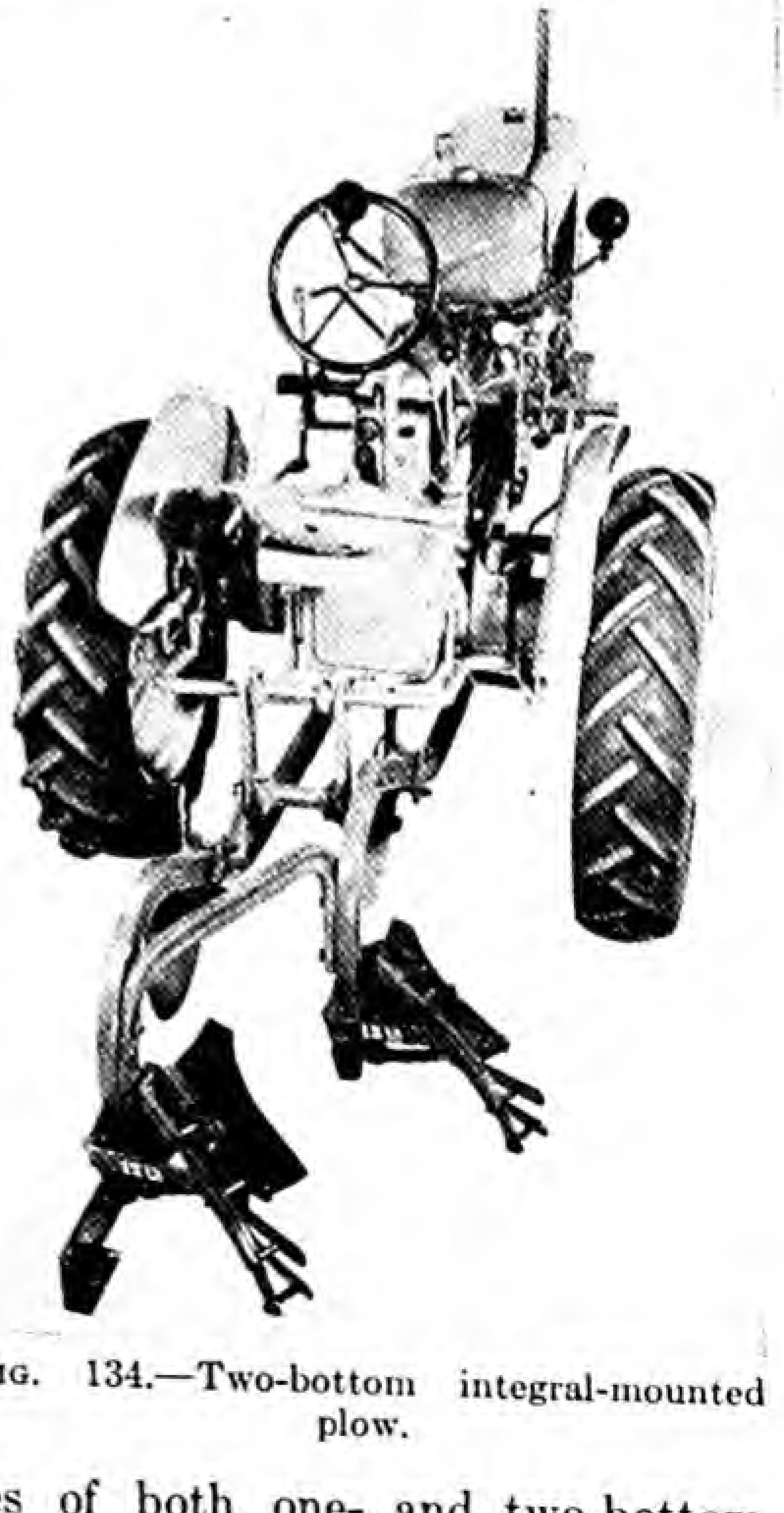


FIG. 134.—Two-bottom integral-mounted plow.

Some tractors have unit assemblies of both one- and two-bottom

plows which are easily interchanged (Figs. 135 and 136). These units are equipped with fixed rolling rear furrow wheels instead of landsides. All two-bottom integral-mounted plows are power-lifted. When in operation some are manually adjusted, while others are hydraulically adjusted. Most integral-mounted plows are attached to the tractor

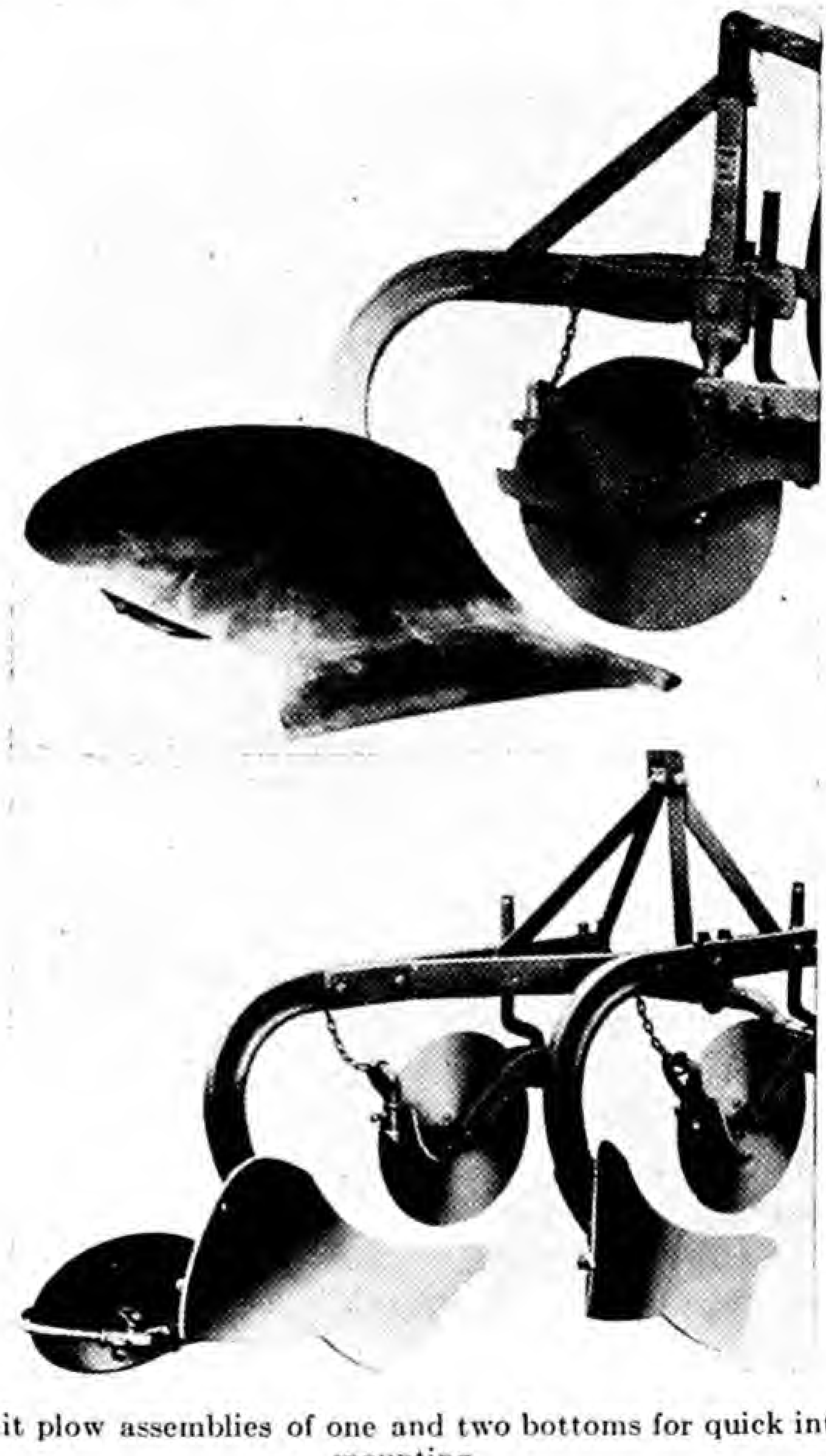


FIG. 135.—Unit plow assemblies of one and two bottoms for quick integral tractor mounting.

in such a way that in lifting the plow the front end of the beam is lifted first, causing the point of the plow to be raised so that the plow is free of soil when it reaches the surface. This eliminates lifting a considerable weight of soil as would occur if it were raised heel first.

The size of bottoms used will be influenced by the soil type and the power available. Integral-mounted bottoms are either 12- or 14-inch

bottoms. Where a single bottom is used the size may range from 12 to 16 inches, again depending on the soil type and power available.

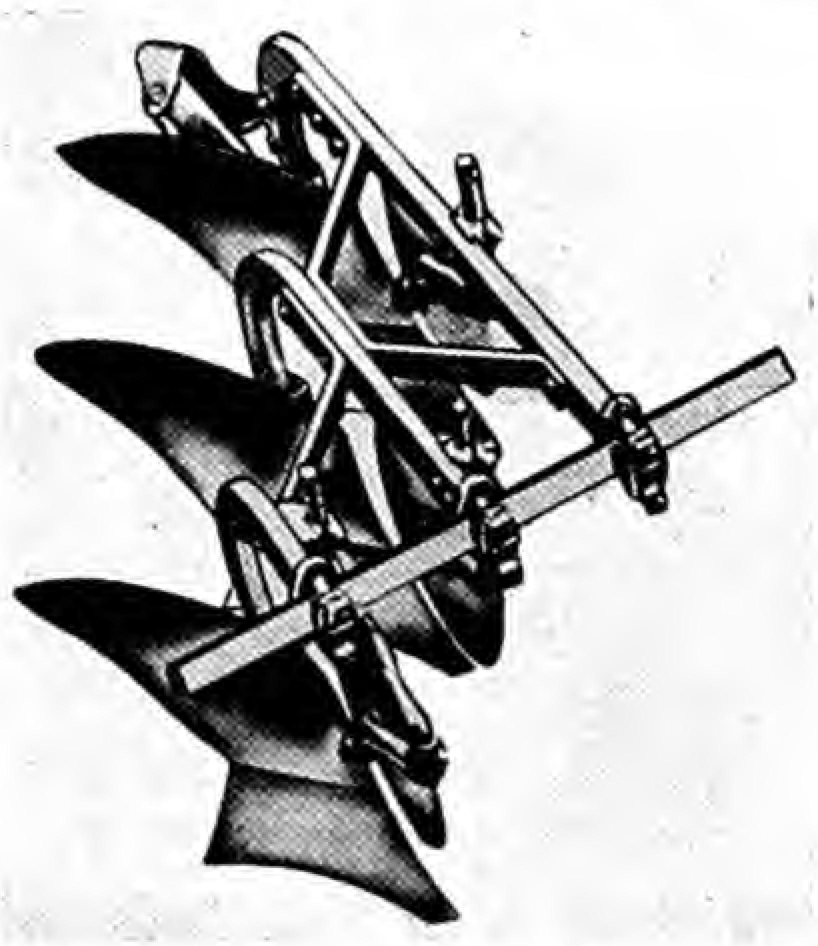


FIG. 136.—Unit assembly of three bottoms makes attachment to the tractor a quick and easy task.

133. Two-way Plows.—The two-way integral-mounted plow consists of two separate and independent units of right- and left-hand bottoms. The units may have one or two bottoms (Figs. 137 and 138) and may be

FIG. 137.—Single-furrow two-way integral-mounted plow using left-hand bottom.

termed *one-furrow* or *two-furrow plows.* The method of mounting, lifting, control, and general design are practically the same as for the regular one-way integral-mounted plow previously described. Each side or set of bottoms is operated independently.

The integral-mounted two-way plow is for one-way plowing, as all the furrows are thrown in the same direction. By being tractor mounted

FIG. 138.—Two-way two-furrow integral-mounted plow.

it is well suited for plowing "strip crop" fields, terraced fields, steep slopes, irrigated lands, and fields where dead furrows are undesirable.

134. Middlebreaker or Listers.—The integral tractor-mounted middlebreaker is also called a *middlebuster*, *bedder*, and *lister*.

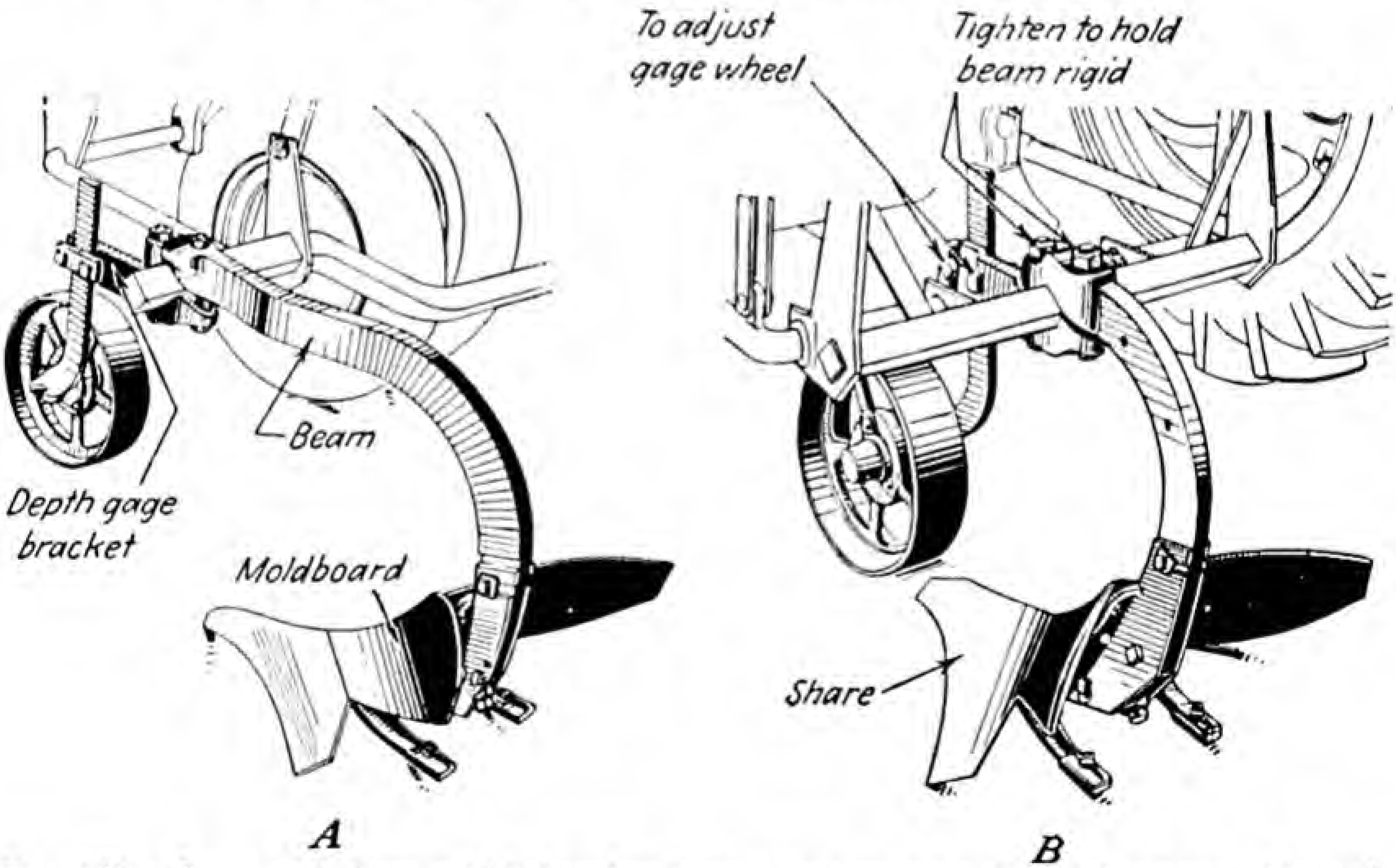


FIG. 139.—Long and short middlebreaker beams and method of attaching to tool bar: *A*, long beam; *B*, short beam.

There are two types of middlebreakers, the rear mounted and the front mounted. They are so called because of their position when mounted on the tractor, in relation to the rear wheels.

The *rear-mounted middlebreaker* is, in most makes, attached to a tool bar (Fig. 139). The long or short beams (Fig. 139) are easily attached and detached. In most makes, the removal of two bolts is all that is necessary. The beams also can be moved sidewise along the tool bar

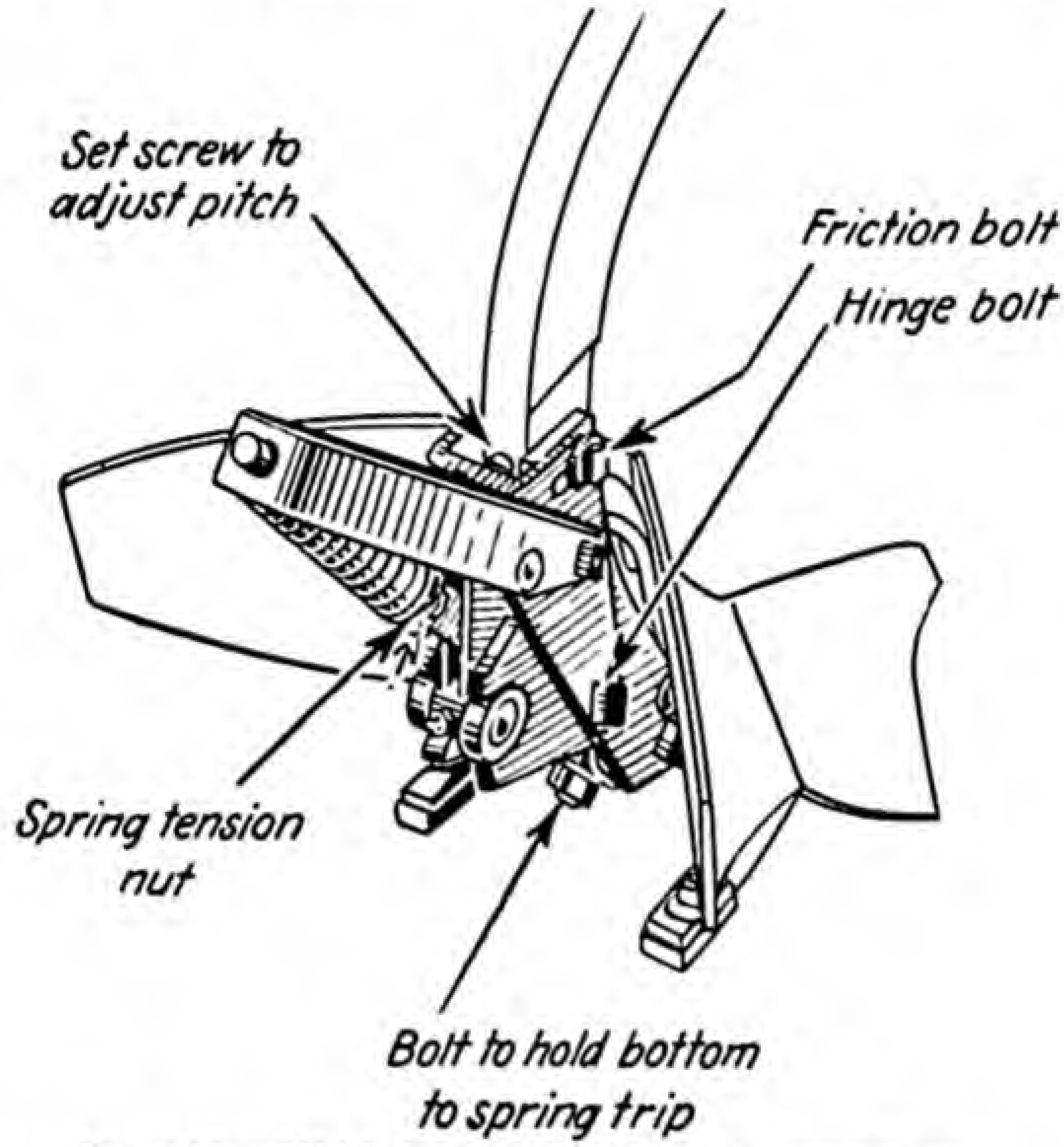


FIG. 140.—Middlebreaker bottom with spring trip.

for different row spacings. When plowing in soil where there may be hidden obstructions, such as roots or stones, a spring trip (Fig. 140) or a friction release may be obtained. After the depth of plowing has been adjusted by levers, it is controlled and held uniform by gage wheels

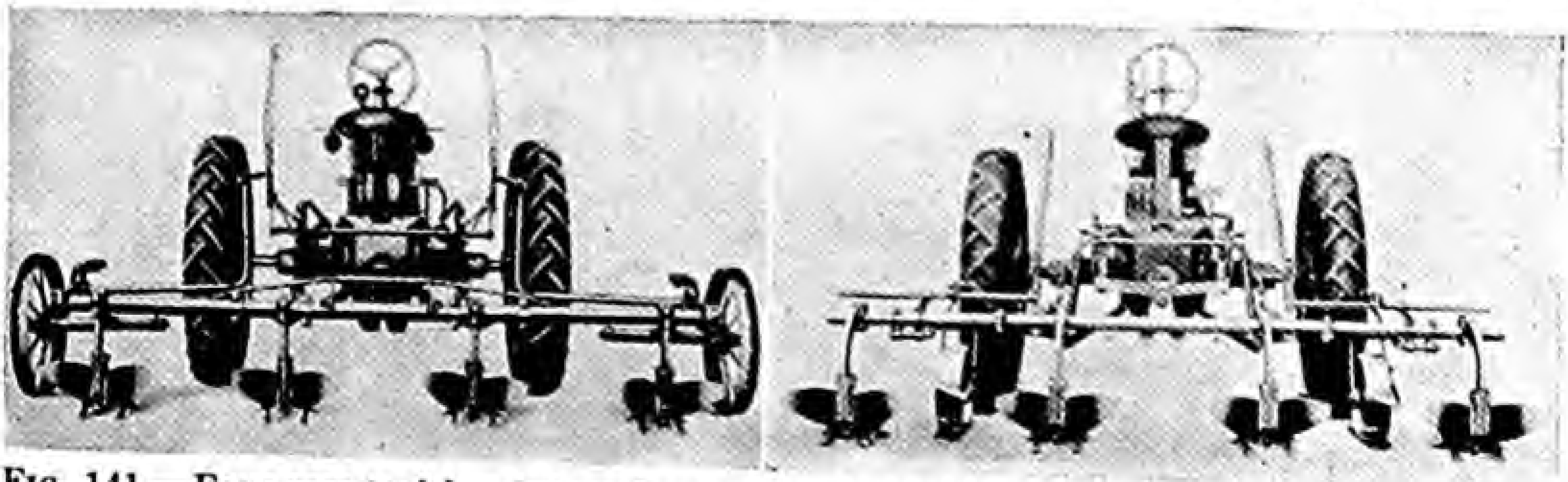


FIG. 141.—Four-row tool-bar integral rear-mounted middlebreakers, showing gage wheels on outside and inside of the outside bottoms.

(Fig. 141). In some makes the gage wheels are attached to the beam in front of the middlebreaker bottom. Most three- and four-row middlebreakers have the gage wheels attached to the tool bar, either at each end or inside the outside bottoms, behind the tractor wheels (Fig. 141).

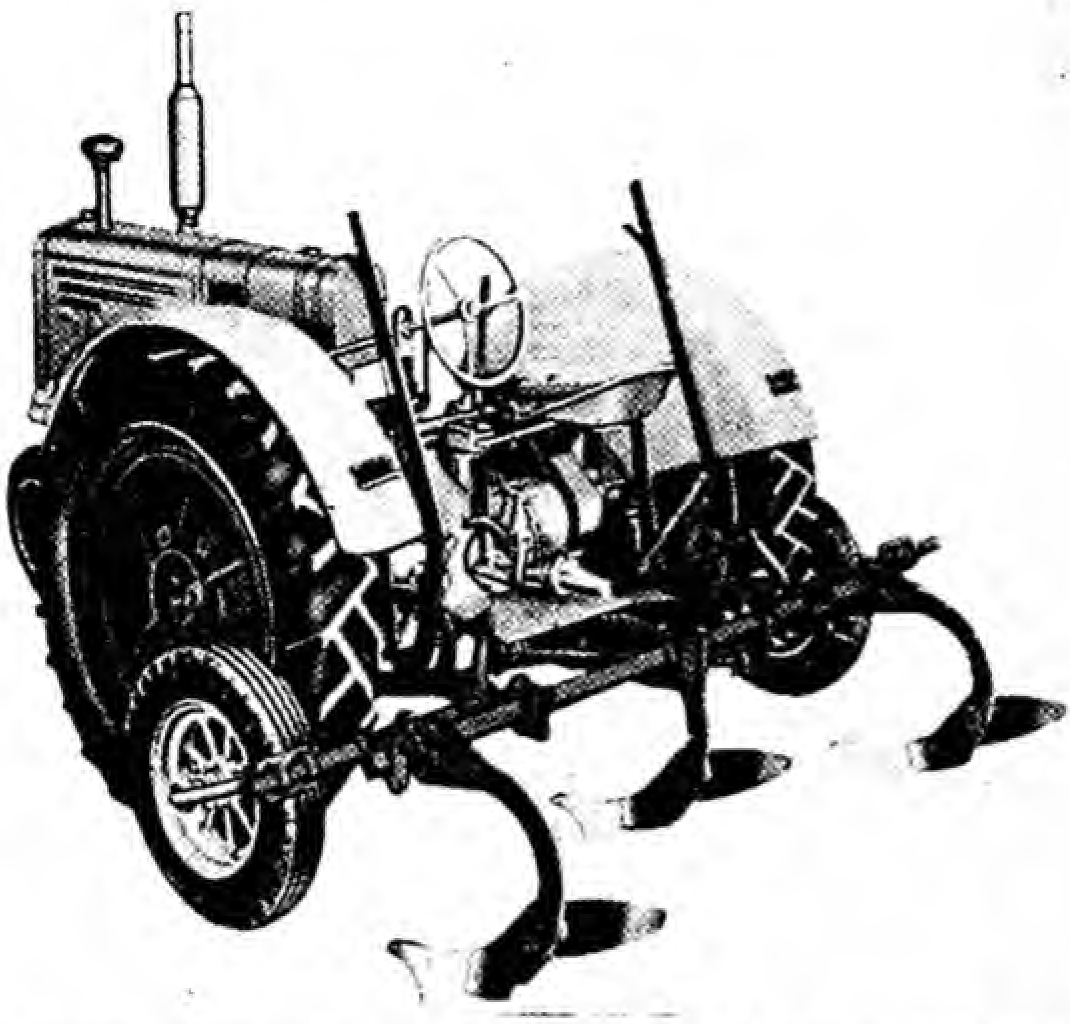


FIG. 142.—Integral tractor-mounted rear tool-bar middlebreaker with pneumatic tires on outside gage wheels.

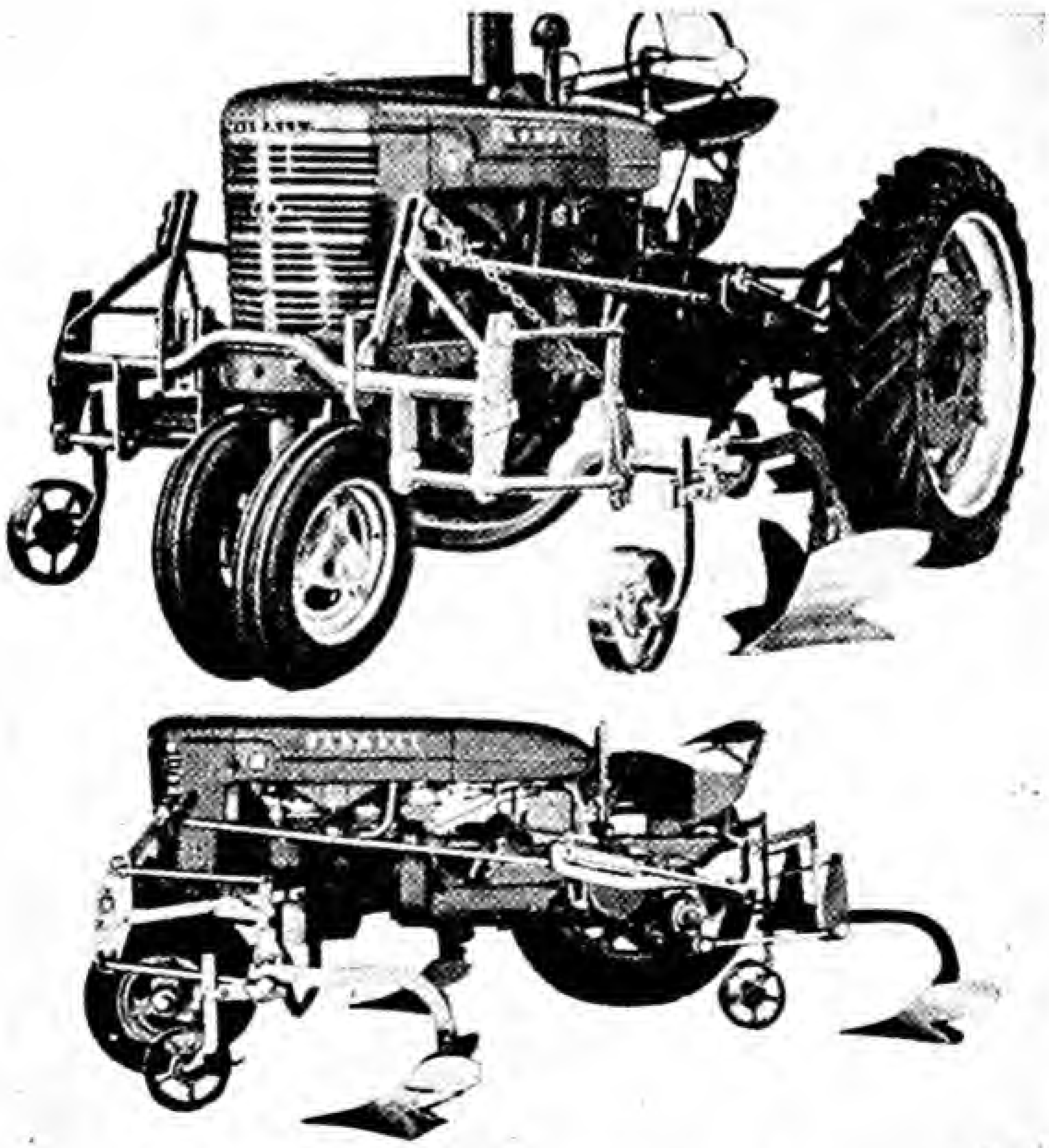


FIG. 143a.—Front and side view of front-mounted or push-type middlebreaker or lister.

Fig. 143*b*.—Rear view of front-mounted lister in operation.

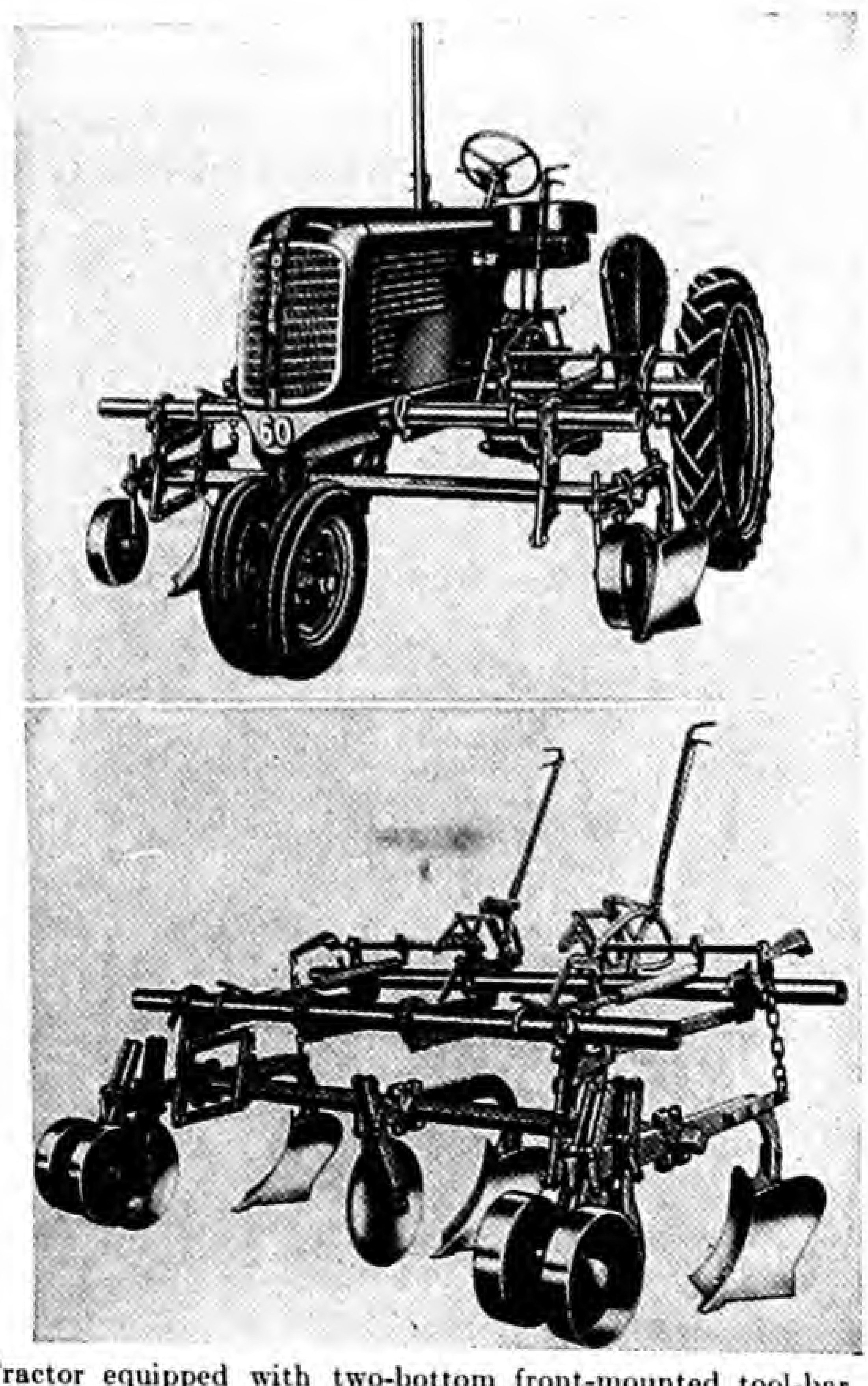


Fig. 144.—Tractor equipped with two-bottom front-mounted tool-bar middlebreaker. Assembled unit is shown with three bottoms.

Pneumatic tires for the gage wheels may be had as an extra accessory (Fig. 142).

The *front-mounted middlebreaker* may be equipped to operate with two or three bottoms, but never more than three (Figs. 143*a* and 144). When mounted in front of the tractor drive wheels, the unit is often referred to as a *centrally mounted* or *suspended* tool. The unit also may be called a *push-type middlebreaker* because the bottoms are pushed forward ahead of the tractor drive wheels.

The front-mounted middlebreaker is equipped with gage wheels, power lifts, and means to adjust for different row spacing.

The front-mounted arrangement makes it possible to use tractors equipped with pneumatic tires in the field when the surface is wet enough to cause excessive wheel slippage. This is because the tractor drive wheels operate in the furrows made by the middlebreaker bottoms mounted in front of the wheels. The surface may be wet, but the tractor wheels operate on comparatively dry soil. Land may be bedded and rebedded and beds reshaped. When the land has been bedded or listed for some time and rains and winds have partially filled the furrows with soil, it is desirable to clean out the furrows with the middlebreaker bottom, throwing some soil up on the edges of the bed and thereby reshaping it. This operation is called "hipping" by farmers of the Mississippi Delta area.

CHAPTER X

DISK-PLOW TYPES

Disk plows, like moldboard plows, are divided into horse-drawn and tractor types. Horse-drawn disk plows are divided into *sulky* and *gang types*. There are three types of tractor disk plows: *trailing*, *direct-connected*, and *integral-mounted*.

HORSE-DRAWN PLOWS

There are no walking disk plows. All horse-drawn disk plows are mounted on three wheels, a land wheel and a front and a rear furrow wheel (Fig. 145). The wheels, instead of being made of light rolled steel

FIG. 145.—Sulky disk plow.

as in the moldboard, are cast and are smaller and heavier. The rim of the wheels instead of being flat is usually flanged or V-shaped. This construction aids in preventing the wheel from slipping sidewise. Provision is made for additional weight by means of weights which can be bolted between or on the sides of the spokes of the wheel, usually on the rear wheel. This may be necessary if unusually hard ground is encountered.

Another difference of construction, in comparison with moldboard plows, is that instead of the plow beams curving over the top of the plow and attaching to the back of the plow bottom, they come from the side. This, of course, does not allow enough clearance and often gives trouble where a large amount of trash is on the land.

135. The Sulky Disk Plow.—The sulky disk plow is a riding horse-drawn single-bottom plow (Fig. 145). The furrow wheels of the sulky disk plow, like those of the moldboard, are inclined. This is to aid the plow in overcoming the side pressure created by the furrow slice upon the plow, which is increased by the rolling of the bottom itself, causing the rear end of the plow to swing around to the left. There are levers for each of the wheels for adjusting and leveling the plow. There is a special lever for landing the front wheel; that is, it can be given more or less lead to or away from the furrow wall.

136. The Gang Disk Plow.—The gang disk plow differs from the sulky disk plow in that there are two or more bottoms. Many of the

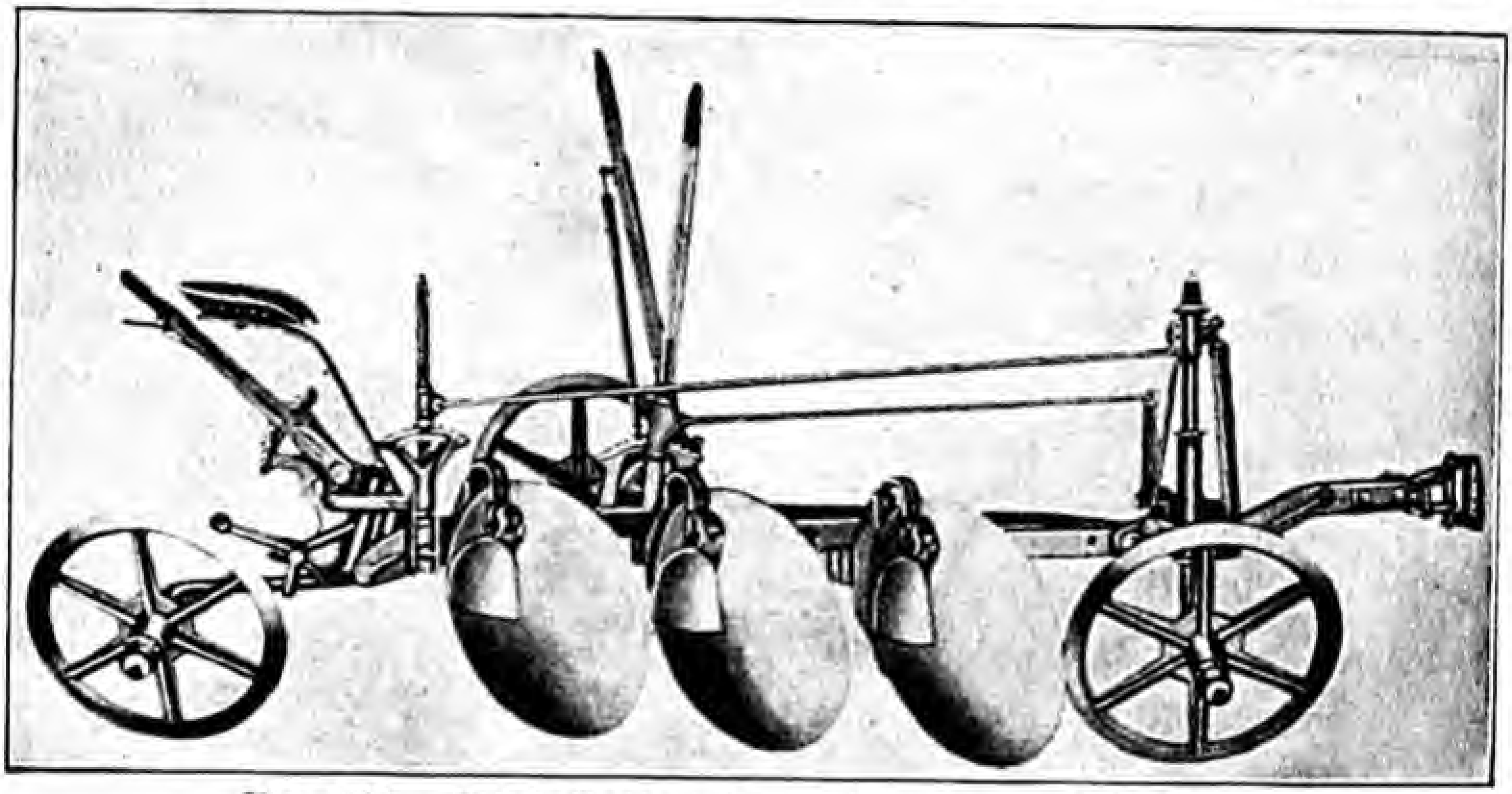


FIG. 146.—Triple-bottom horse-drawn gang disk plow.

sulky plows are so constructed that they can be changed into gang plows by adding another bottom, making either a two- or three-disk plow (Fig. 146). For this reason, this type of plow is sometimes called a *multiple gang* plow. The construction of the disk, frame, wheels, and arrangement of the levers is practically the same as for the sulky plow.

TRACTOR DISK PLOWS

As stated above, tractor disk plows are divided into trailing, direct-connected, and integral-mounted types. The trailing disk plows can be divided into two types, *regular* and *harrow.*

Trailing Disk Plows

Trailing disk plows, as the name indicates, are pulled behind the tractor. The plow is a unit in itself and is attached to the tractor by a hitch that can be adjusted both vertically and horizontally. In the older models the frame is arranged to the side and below the top of the disk bottoms. This is called a *side-frame* plow (Fig. 150). Newer models

of trailing disk plows have a high frame above the disk. This is called an *overhead-type* disk plow (Figs. 147 and 148). Longer standards are required to attach the disk bottoms to the overhead frame than to the side frame. The high frame gives sufficient clearance for plowing in trashy fields. Arrangements are provided for adjusting the vertical angle of the disk, which influences penetration. Figure 149 shows three

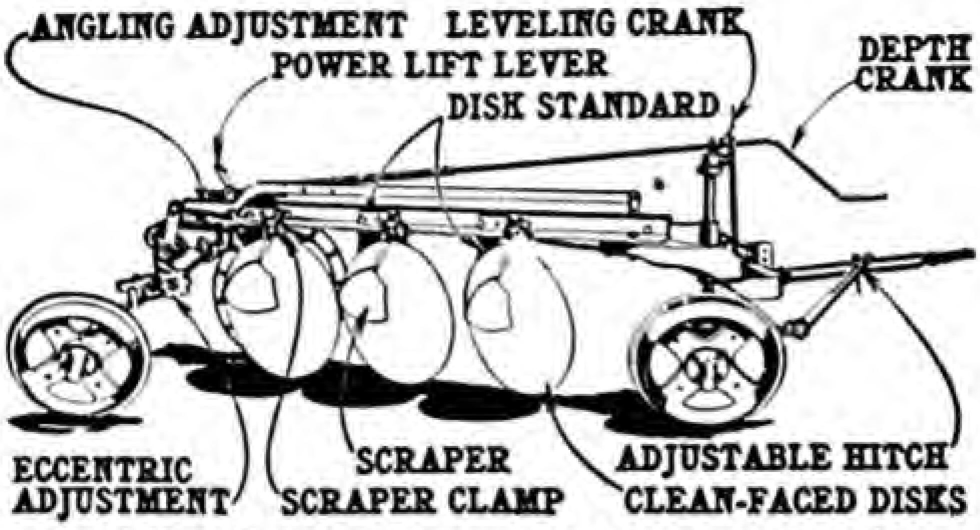


FIG. 147.—Overhead-frame engine gang disk plow.

positions of vertical adjustment. Like all trailing plows the trailing disk plow is provided with three wheels—two furrow wheels and a land wheel. The front furrow wheel is at the front end of the frame and is connected to the hitch to aid in guiding and turning the plow. The rear furrow wheel is usually allowed to swivel on left-hand turns but is limited in its

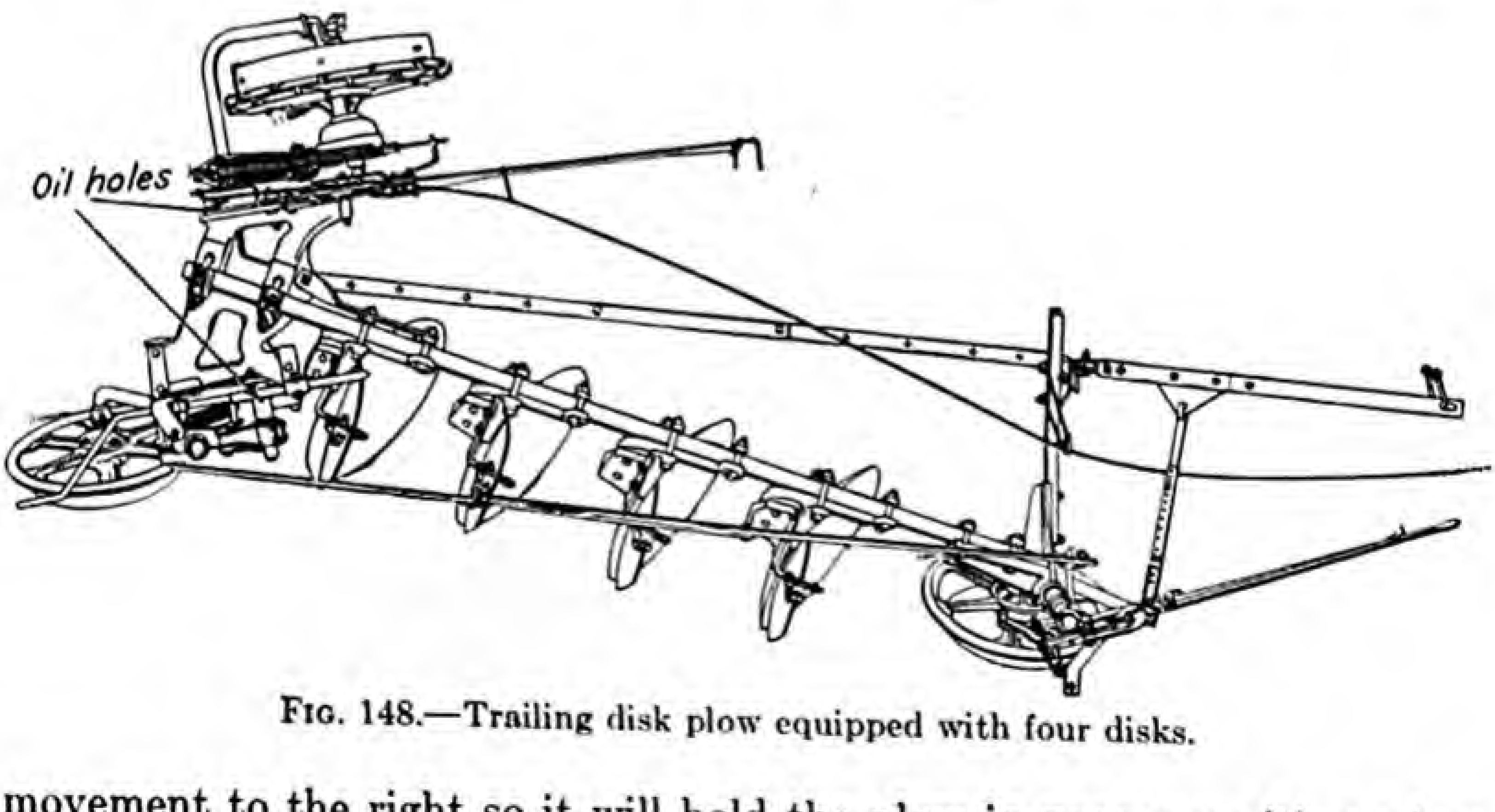


FIG. 148.—Trailing disk plow equipped with four disks.

movement to the right so it will hold the plow in proper position when plowing. Both furrow wheels are inclined to hold the plow in position (Fig. 148). The land wheel is usually located toward the rear of the plow but slightly forward of the rear furrow wheel. The power lift is always a part of the land wheel. When plowing hard soils, additional weights on the wheels will help to hold and steady the plow. If desired,

the wheels may be equipped with rubber tires. Levers and screw cranks provide a means of adjusting for depth and for leveling the plow.

Heavy-duty disk plows can be obtained for deep plowing and for plowing in heavy soils (Fig. 150).

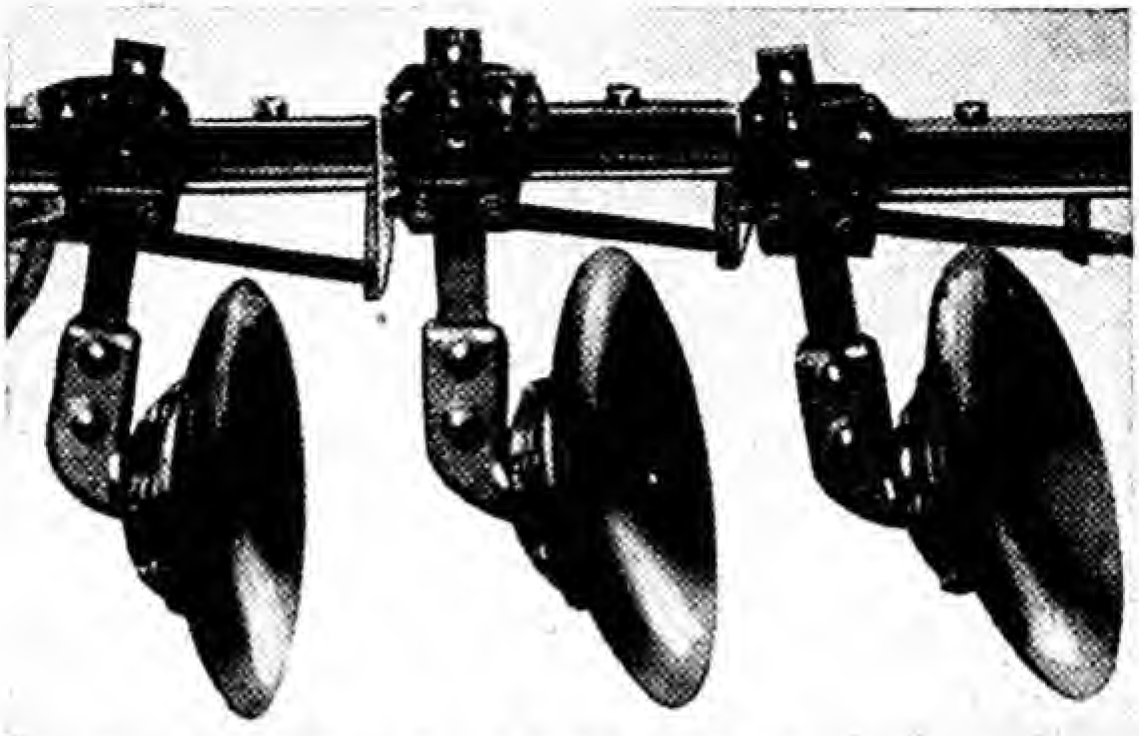


FIG. 149.—Showing how vertical angle of disks can be changed on an overhead-type disk plow.

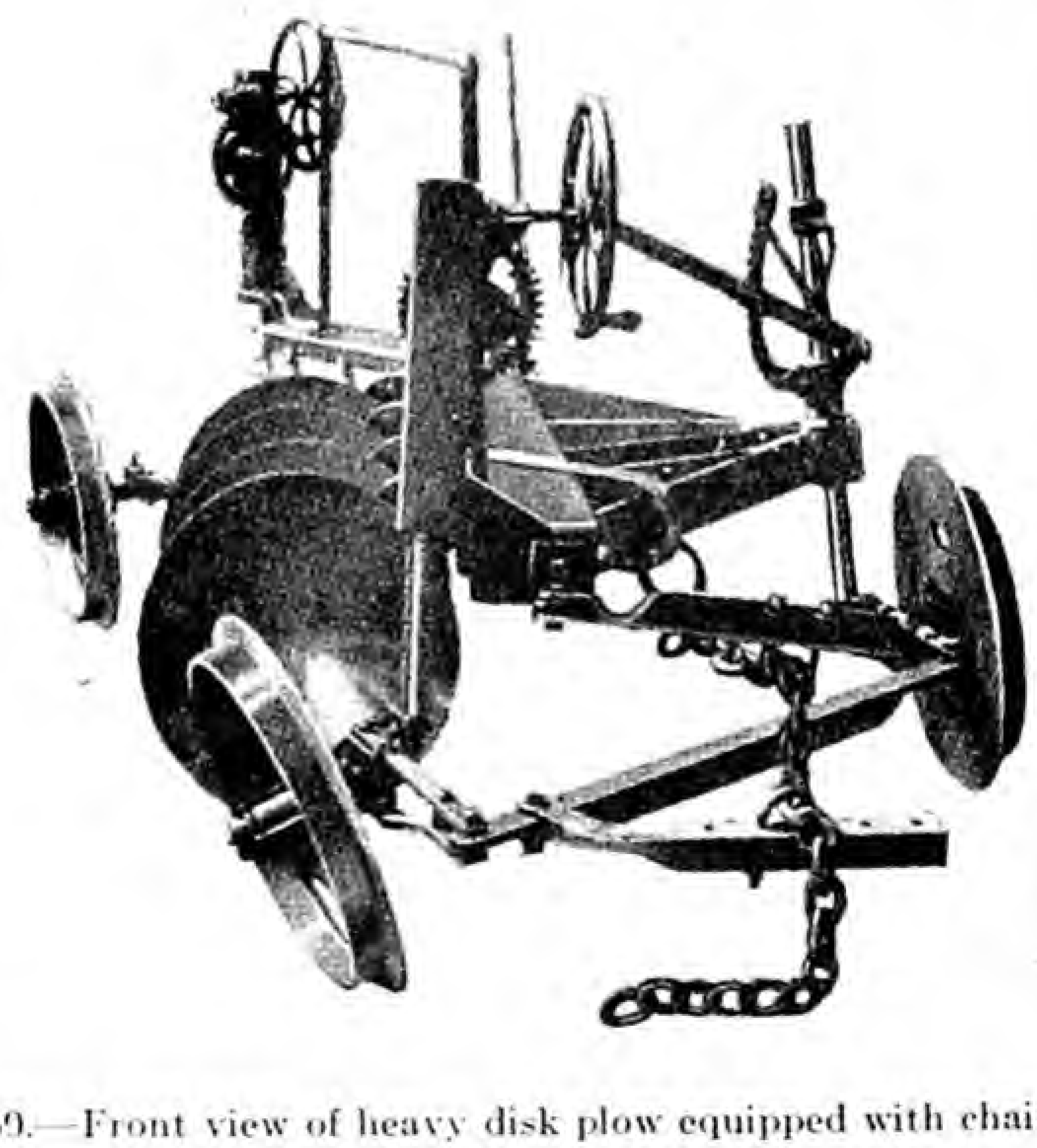


FIG. 150.—Front view of heavy disk plow equipped with chain hitch.

137. The Harrow-Plow.—As shown in Fig. 152, the harrow disk plow is a combination of the principles of the regular disk plow and the disk harrow and is often termed a *one-way*, *wheat-land*, *cylinder*, *harrow*, or *tiller plow*. It has the frame, wheel arrangement, and depth-adjust-

ing devices of the disk plow, while the arrangement of the disks and their attachment to the frame are like those in the disk harrow. All the disks on the plow are arranged on a single shaft. The bearings are

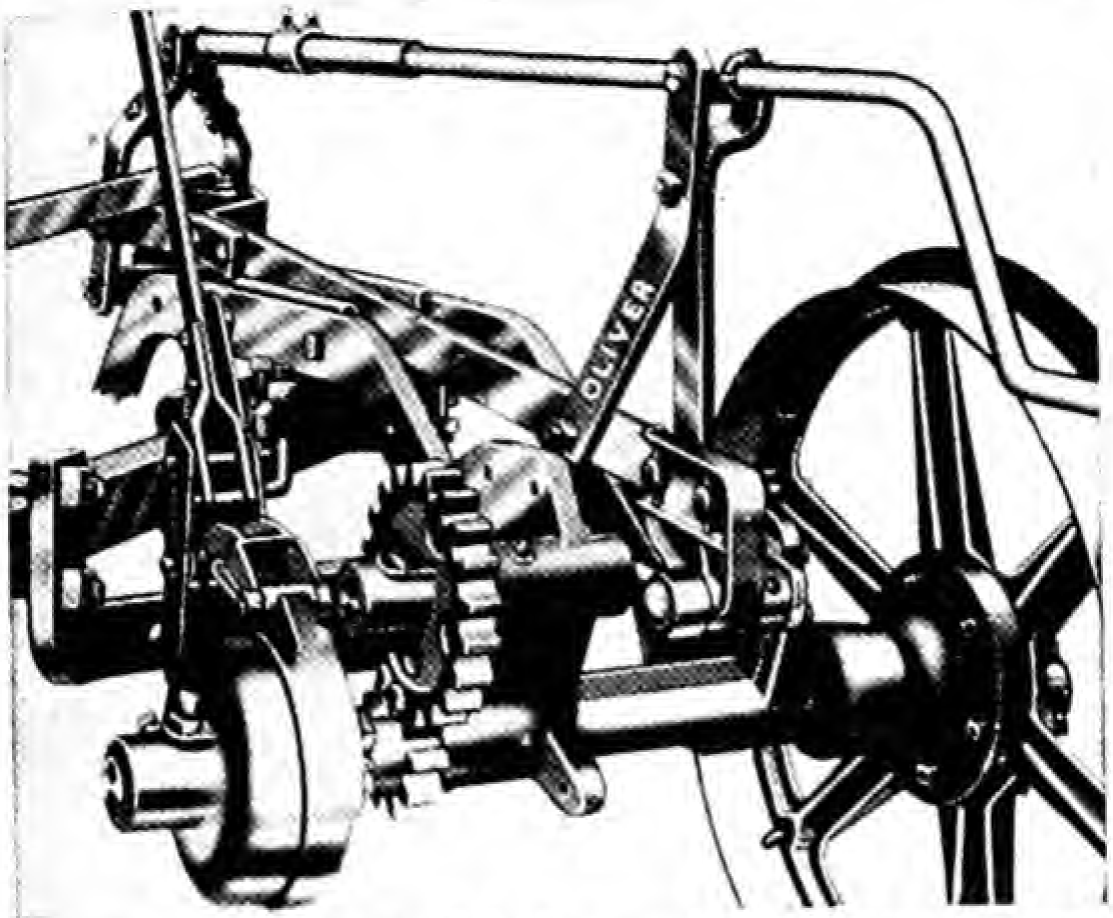


FIG. 151.—The power-lift for a heavy disk plow employs a gear mechanism to help raise and lower the plow.

also arranged somewhat like the bearings on a disk harrow. However, the disks are all set to throw the soil one way and turn together as a unit similar to a single gang of a disk harrow. It is made in different

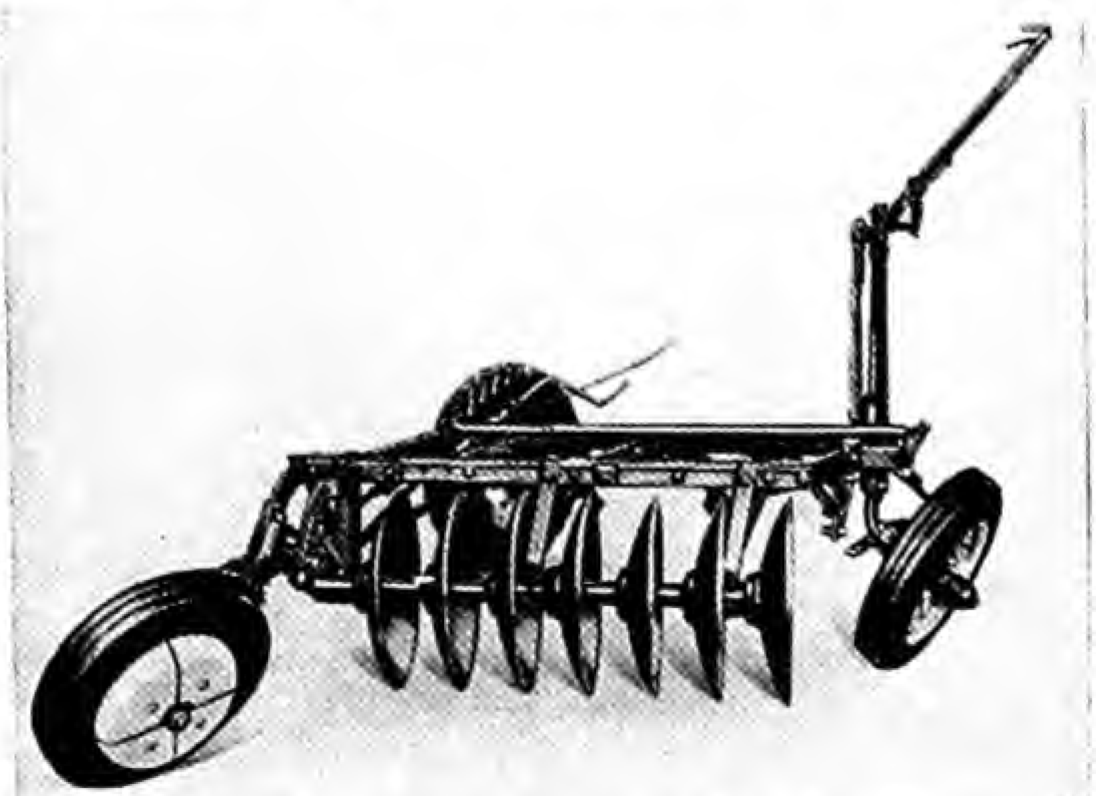


FIG. 152.—Harrow-plow equipped with rubber tires.

sizes to cut strips 3½, 5, 6, 8, 10, and 17½ feet wide. The number of disks used on a plow may vary from four to thirty.

The larger plows are constructed so that sections can be removed and the size of the plow reduced (Fig. 153). It is claimed that 25 to

40 acres can be plowed in a day with the larger plows of this type. The size of disk used may range from 20 to 26 inches in diameter.

Small harrow-plows equipped with three, four, or five disks are avail-

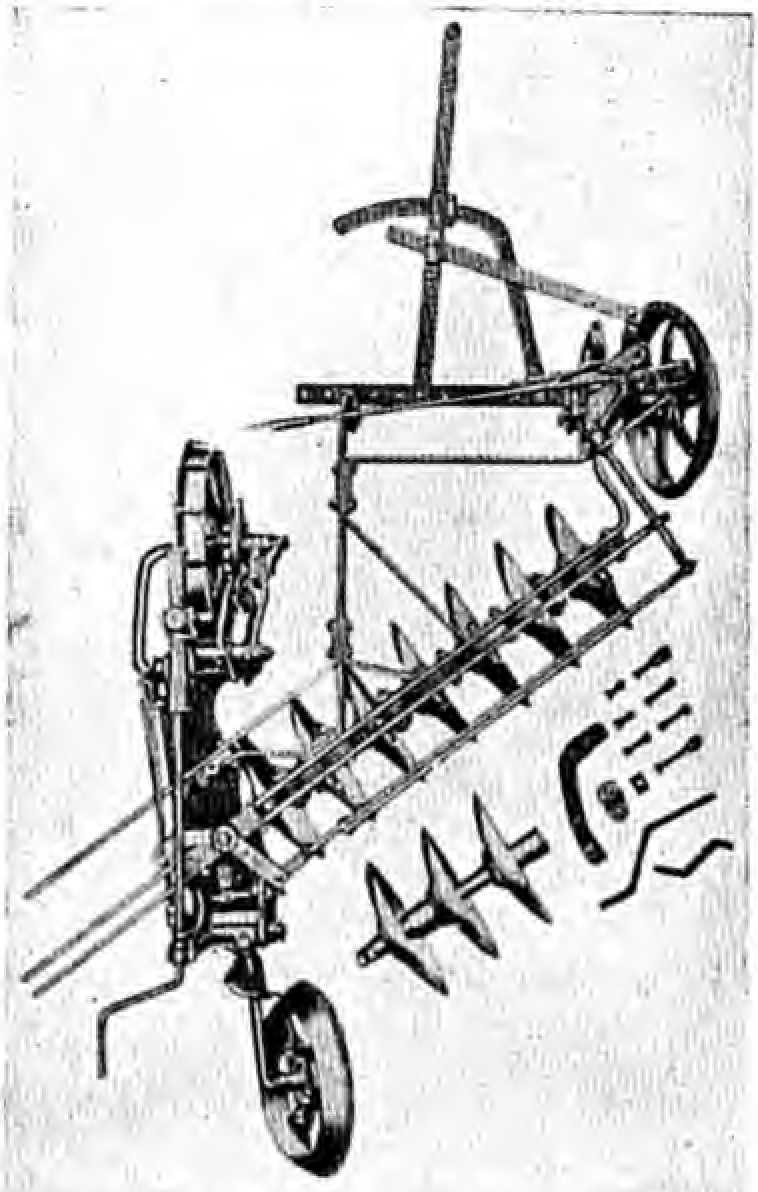


FIG. 153.—Overhead view of a ten-disk one-way plow reduced to seven-disk size. Note disks and parts for increasing to ten-disk size.

able for use with small tractors (Fig. 154). Grain-drill seed boxes may be mounted on the medium sizes of the harrow-plow so that grain and grass seeds can be sown while plowing (Fig. 155).

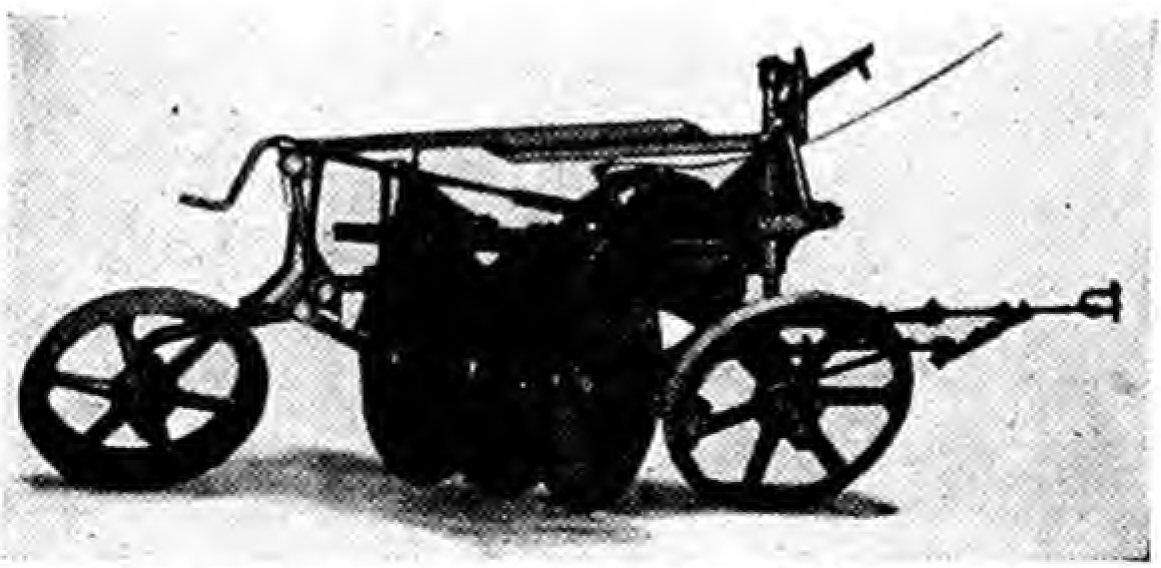


FIG. 154.—A small one-way harrow-plow equipped with three disks on a single axle. It will plow a strip 15 to 17½ inches wide.

The harrow-plow can be used to build broad-base terraces. More soil is moved up on the terrace if the plow is pulled at a fast speed of 3½ to 4 m.p.h. At least one make of harrow-plow is equipped with

eccentric disks for the forming of pits or basins much like those formed by the basin lister. Every alternate disk is a 20-inch disk, with the hole 2 inches off center. Between each two eccentric disks there is an 18-inch disk with the hole in the center. The eccentric disks are arranged so that no two are cutting their full depth at the same time.

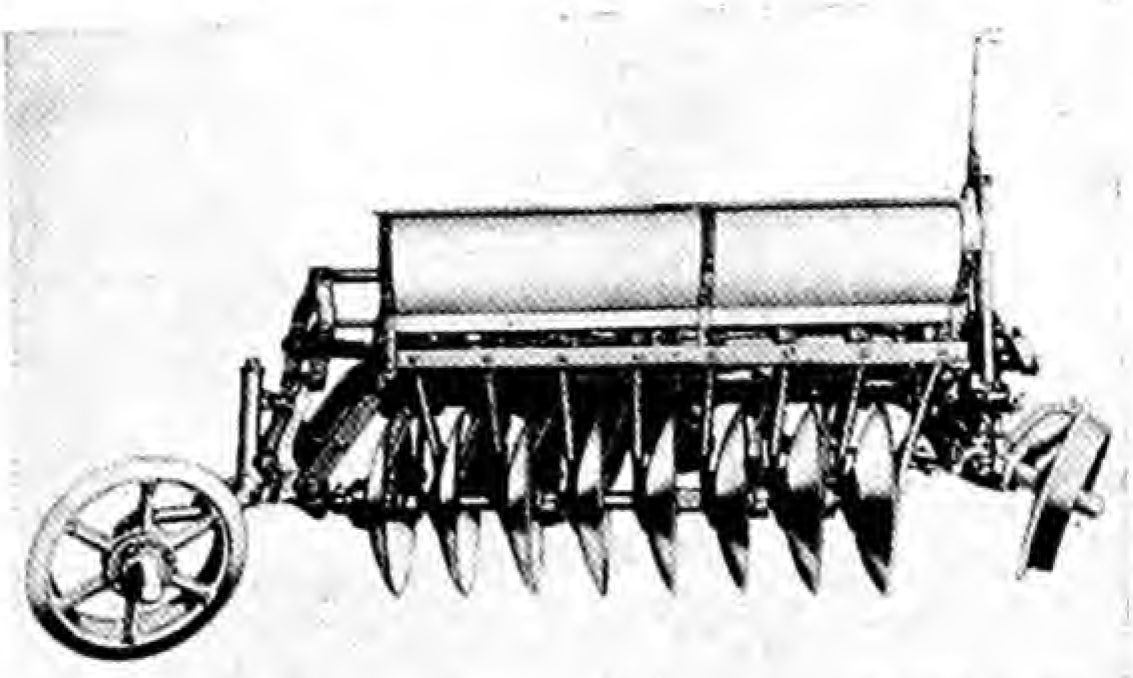


FIG. 155.—A medium-sized one-way harrow-plow equipped with a grain-drill seed-box attachment.

138. Orchard Disk Plows.—Figure 156 shows a disk plow constructed without any long levers to catch overhanging branches. The wheels are set inside the frame to allow passing close to trees. The hitch is designed to allow the plow to be shifted to either the right or left, which makes plowing close to trees possible.

FIG. 156.—Special orchard disk plow.

DIRECT-CONNECTED-PLOWS

A special disk plow designed for the general-purpose row-crop tractor connects directly to the tractor, eliminating the front furrow wheel and the land wheel (Figs. 157 and 158). A furrow wheel supports the rear end of the plow. This close-coupled plow is compact and easy to handle. It is easy to maneuver because short turns can be made, enabling the operator to work close to fences. It also can be backed into corners.

The rear wheel is automatically controlled from the steering mechanism at the front of the tractor. These plows are built in three sizes, according to the number of bottoms. The one-furrow plow is for the small tractor, the three-furrow for the larger general-purpose tractor (Fig. 157),

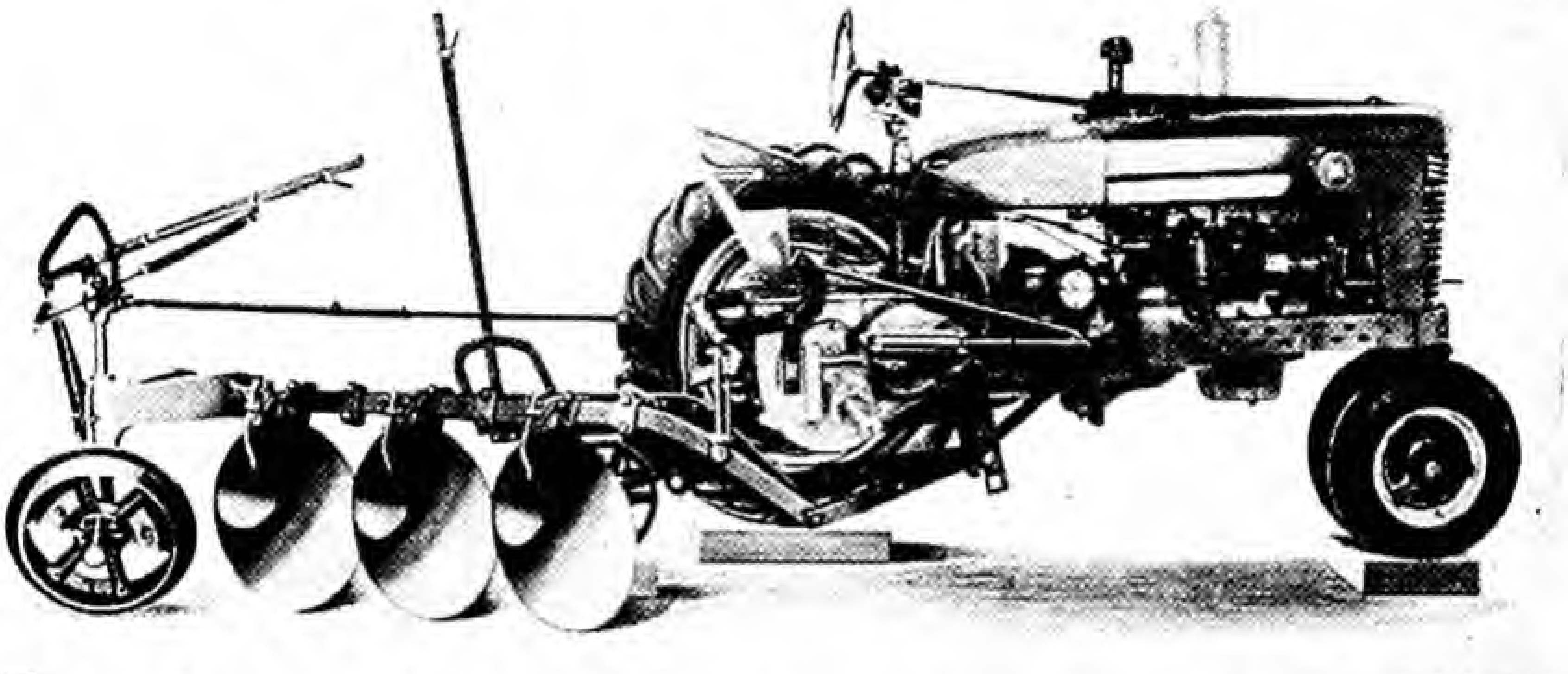


FIG. 157.—A three-disk direct-connected plow. Note hydraulic-lift arrangement.

and the two-furrow for intermediate conditions of soil and power requirements. A hydraulic lift raises the front of the plow high enough so it can be turned and transported easily. Depth of plowing is adjusted by

FIG. 158.—A two-disk plow of the direct-connected type equipped with rubber tires.

the lever at the rear. Wheel weights and scrapers for the disks can be obtained.

Figure 159 shows a direct-connected plow with three disks provided with a tool bar as a means of attaching the plow as a unit to the tractor.

FIG. 159.—A direct-connected type of plow provided with a tool bar.

INTEGRAL-MOUNTED DISK PLOWS

The integral tractor-mounted disk plow shown in Fig. 160 is attached rigidly to the right-hand side of the tractor, forward of the rear wheel or centrally between the front and rear wheels. The plow is raised, lowered,

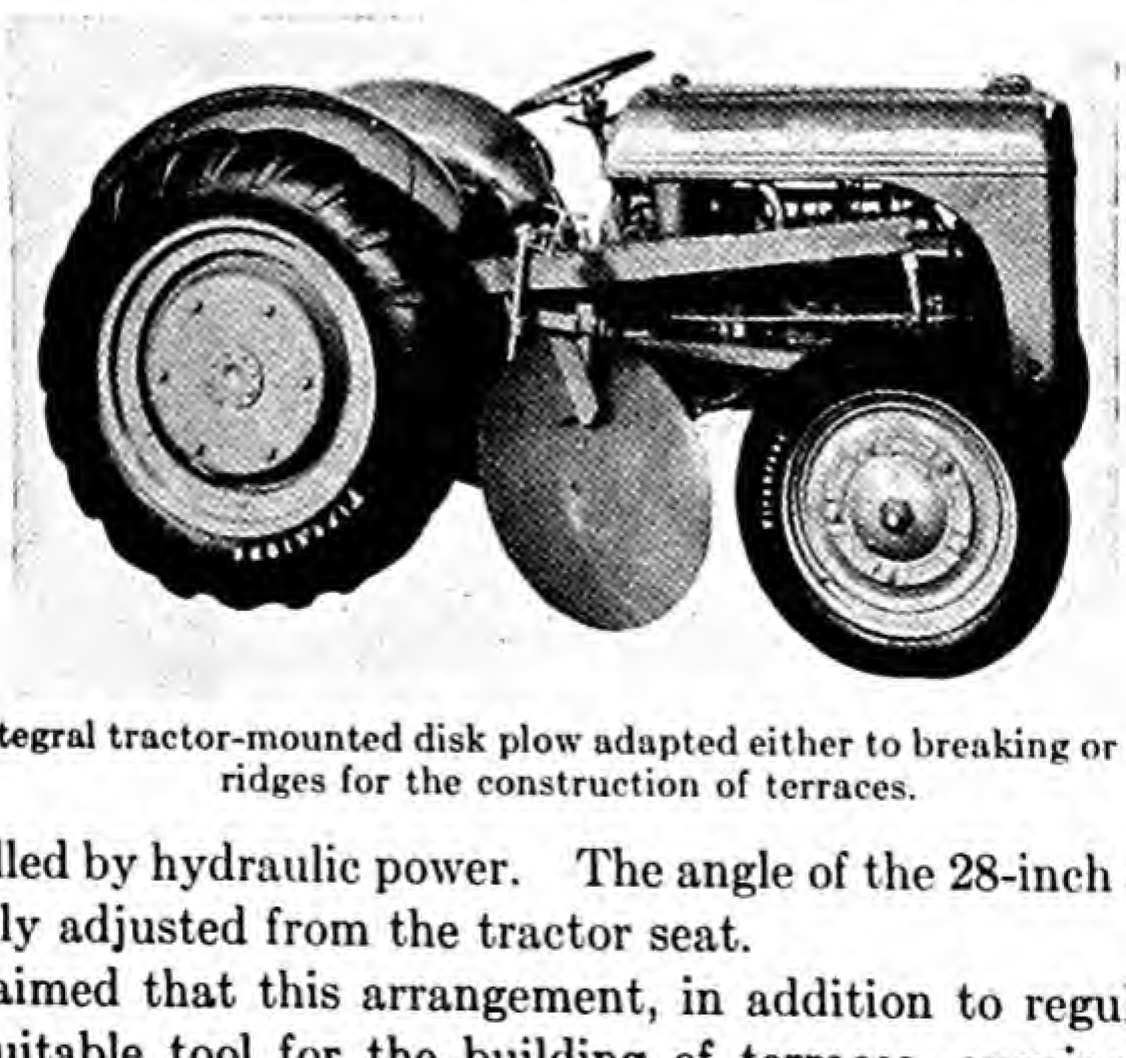


FIG. 160.—Integral tractor-mounted disk plow adapted either to breaking or to throwing up ridges for the construction of terraces.

and controlled by hydraulic power. The angle of the 28-inch disk bottom can be easily adjusted from the tractor seat.

It is claimed that this arrangement, in addition to regular plowing, makes a suitable tool for the building of terraces, opening of shallow ditches, and filling in of ditches and gullies.

CHAPTER XI

ROTARY PLOWS

Rotary plows are discussed separately from moldboard and disk plows because they are of an entirely different design. They are neither moldboard nor disk plows.

Shawl[1] states that the rotary plow was invented about 90 years ago. The rotary plow has been used in Europe for many years, but the American farmer has only recently become interested in this type of plow. The reason for this lack of interest was the high cost and the large power requirements. In general, rotary plows may be divided into three types: the pull auxiliary-engine, the pull power-take-off-driven, and the self-propelled garden type.

139. Pull Auxiliary-engine Rotary Plow.—Figure 161 shows a rotary plow that is pulled forward by a tractor but has the cutting knives driven

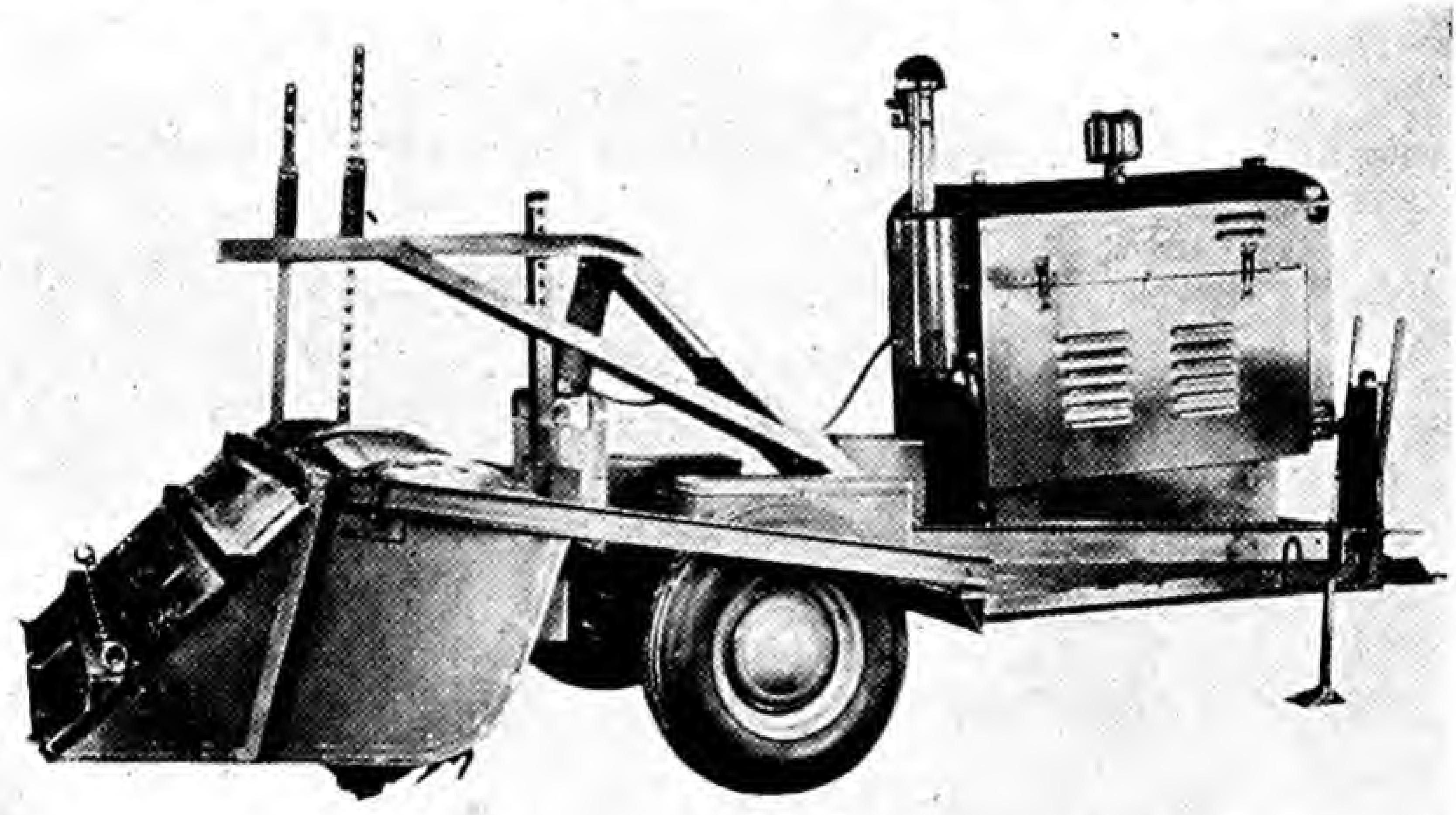


FIG. 161.—Pull-type rotary plow equipped with auxiliary engine for driving the cutting knives.

by an auxiliary engine mounted on the frame of the plow. This type of plow is made in 4-, 5-, and 6-foot sizes and requires 60 to 90 horsepower. The cutting knives are mounted on a horizontal power-driven shaft.

[1] SHAWL, R. I., Rotary Plowing as a Means of Seedbed Preparation, *Farm Implement News*, Vol. 67, No. 6, pp. 50–53, 1946.

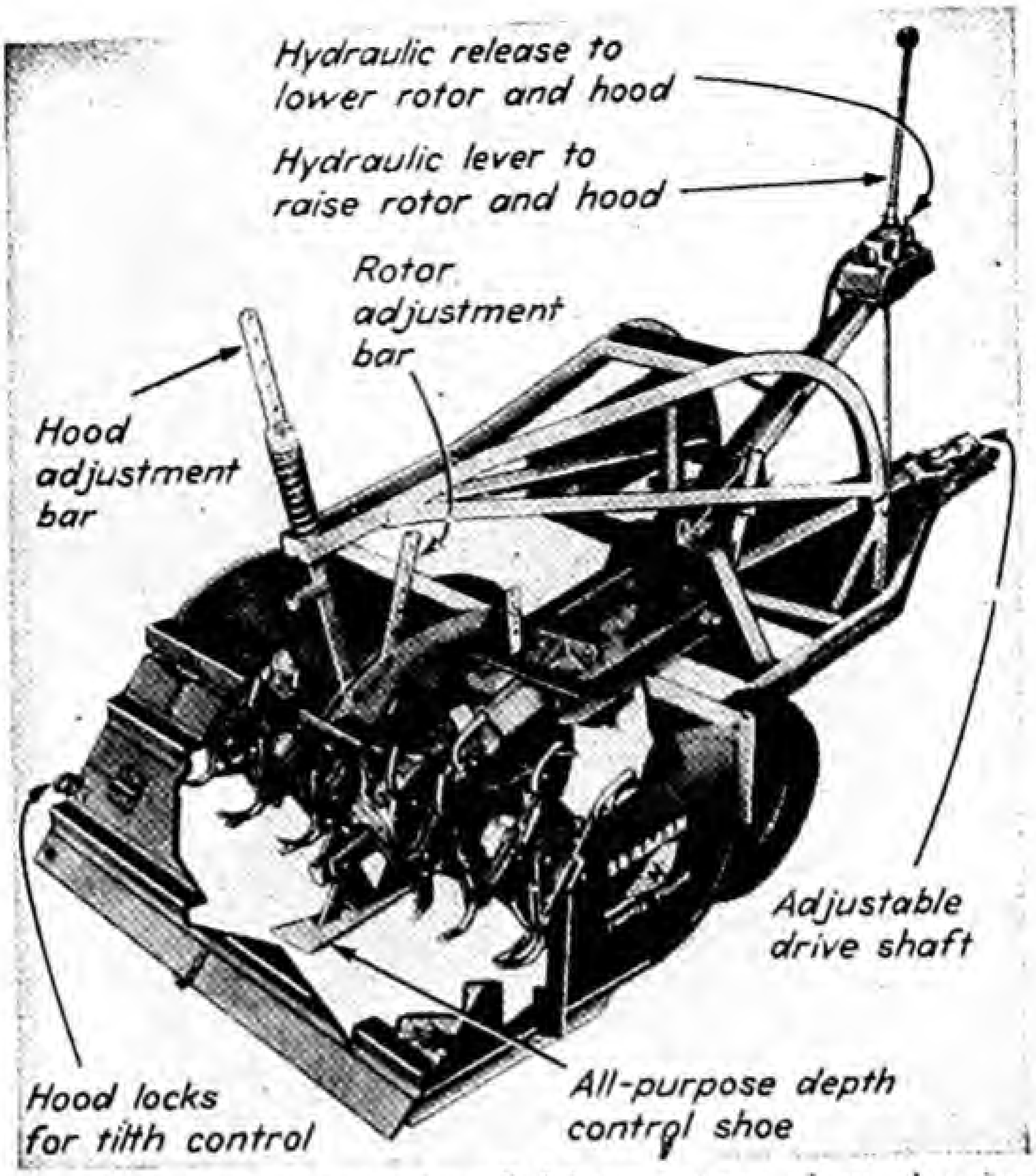


FIG. 162.—Sectional view of power-take-off-driven rotary plow, showing cutting knives mounted on horizontal shaft.

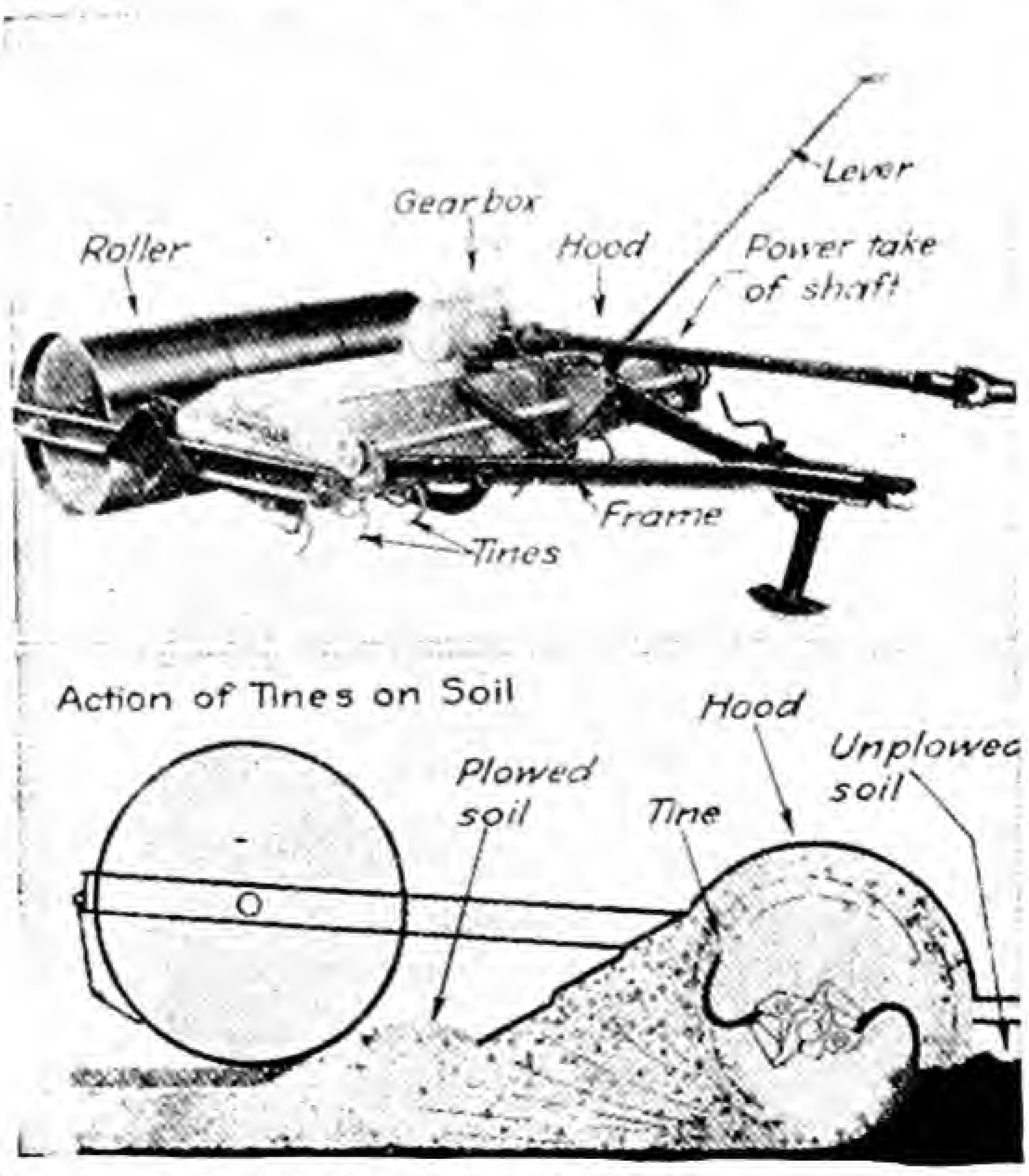


FIG. 163.—Rotary plow operated by power-take-off of tractor and equipped with roller to compress the soil.

Tractor-propelled, auxiliary-engine-driven rotary cultivators are also available.

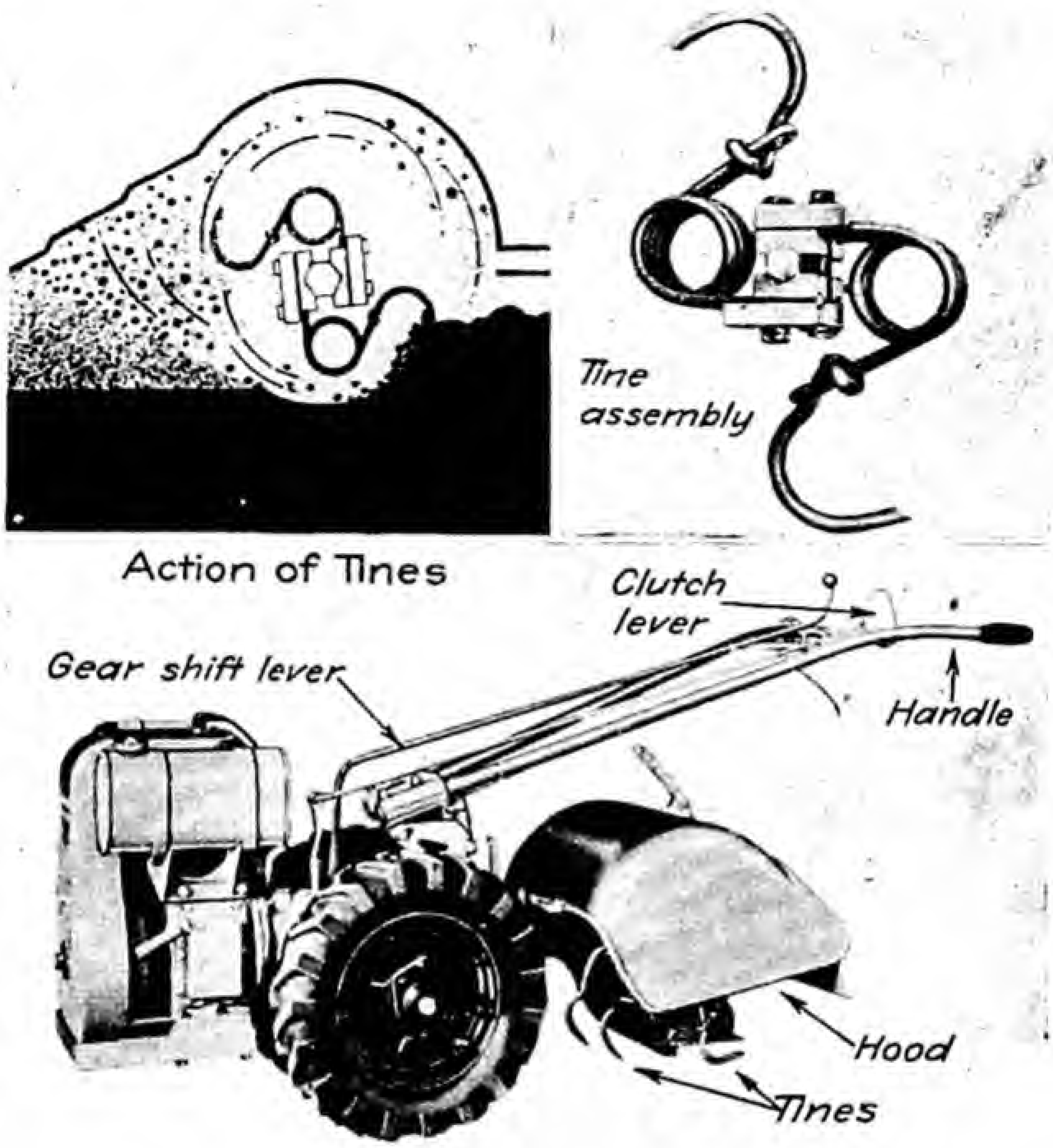


FIG. 164.—Rotary plow of the garden-tractor type.

140. Pull Power-take-off-driven Rotary Plow.—The rotary plow shown in Figs. 162 and 163 is not only pulled forward by the tractor but

FIG. 165.—Auger-type rotary plow.

has the cutting knives also driven by the tractor. This type is usually 3 to 4 feet wide and requires 10 to 15 horsepower for each foot of width.

The cutting knives or tines are generally mounted on a horizontal power-driven shaft which operates at about 300 r.p.m. The knives on some machines are provided with a shock-cushioned friction clutch that prevents the knives from breaking when they come in contact with a rock or solid obstacle.

141. The Self-propelled Garden-type Rotary Plow.—Some of the garden-type rotary plows have one drive wheel, while others have two (Fig. 164). They plow a strip 9 to 30 inches wide and are powered by 6- to 15-horsepower engines. They can be operated at two speeds forward—low $\frac{1}{2}$ to 1 m.p.h., high 1 to $2\frac{1}{4}$ m.p.h. The reverse speed is $\frac{3}{4}$ to $1\frac{1}{2}$ m.p.h. Some garden-type rotary plows can be also used for cultivating vegetable crops. The narrow width of 17 inches or less makes it possible to plow narrow strips in a garden where single rows of vegetables have been removed.

CHAPTER XII

PLOW DESIGN

The design of the plow is one of the big problems that has never been entirely solved so that a single shape will perform satisfactorily under all soil conditions, yet more work has been done to perfect the plow bottom than on any other agricultural implement. Upon its performance depends the quality of the seedbed the farmer can prepare, which in turn will influence the germination of the seed, the growth of the plant, and the yield that will be obtained in the end.

142. Judging Plowing.—Before going into the discussion of the design of the bottom for doing good plowing, one should consider first what constitutes good plowing. Good plowing consists of turning and setting the soil into even, clean, straight furrows of roundish conformation. The main points to consider are the following:

1. The top of the furrow may be slightly ridged.
2. The soil must be pulverized thoroughly from the top to the bottom of the furrow.
3. Each furrow must be perfectly straight from end to end.
4. All back furrows must be slightly raised and all trash completely covered.
5. The outline of the furrows must be in a point without break or depression.
6. All trash must be buried completely in the lower right-hand corner of the furrow.
7. Furrows must be thoroughly uniform with one another.
8. The depth of all the furrows must be the same, continuing in uniform depth.
9. The dead furrows must be free from all trash on the ground.

These are rules by which a plowing test may be judged. However, if these rules were followed in all sections of the country where different types of soil are found, the best seedbed would not always be made. The main things to consider in plowing are that the land is completely broken and that the soil is thoroughly pulverized and inverted, with no air spaces left between the furrows. These are conditions that may be applied to any section. The whole bottom is essential for good plowing, the share cutting and slightly lifting the furrow slice, the landside controlling and steadying the plow, while the moldboard completes the lifting, pulverizing, and inverting of the furrow slice. It is upon the moldboard that the main part of successful plowing depends. The curvature and length of the moldboard determine the degree of pulverization the furrow slice will be given.

143. Forces That Act on the Plow.—Lindgren and Zimmerman[1] analyze the many forces that act upon the plow bottom as follows:

First, the principal vertical forces: (*a*) that are due to the weight of the plow; (*b*) that are due to the downward pressure exerted during the lifting of the soil; (*c*) the lifting component due to the hitch being above the point of resistance; and (*d*) that force developed when the plow is dull and worn and that has the upward component, the result of the sloping undersurface of the share.

Second, the principal horizontal cross-furrow forces: (*a*) the cross component caused by the friction of the soil on the moldboard; (*b*) by transferring the soil sidewise the width of the furrow; (*c*) the cross component due to cutting and wedging of the sloping share edge in operation; (*d*) the component of the line of draft; and (*e*) such cross component as may result from the rear furrow wheel reactions in multiple outfits, where used.

Third, the principal longitudinal forces acting lengthwise of the furrow: (*a*) the soil resistance to cutting; (*b*) the friction between the furrow wall and the landside; (*c*) the friction due to the weight and pressure upon the bottom of the plow according to the setting or condition of the cutting wedge; (*d*) the component of the friction of the earth sliding over the moldboard. For equilibrium we have the sum of the draft produced by the motive power.

Thus it can be seen that the moldboard, which is a modified warped surface, as analyzed by White,[2] will have a great deal to do with the proper functioning of the plow, depending upon its width, curvature, and length. Moldboards which have a greater curvature, being bluffer, will naturally give a better pulverizing action upon the furrow slice because of their pinching, crushing action.

144. Center of Resistance or Center of Load of a Plow Bottom.—A point where all three of these forces meet is considered to be the *center of resistance or load.* It cannot always be determined just exactly where this point will be on a plow bottom, but it will usually come within the range of the following dimensions for a 14-inch bottom. Vertical forces will be in equilibrium 2 to 2½ inches up from the floor; the horizontal forces 2 to 3 inches to the right of the shin; the longitudinal forces 12 to 15 inches back from the point of the share. Briefly, we can say that the center of resistance of any moldboard plow bottom will be on the surface about where the share and moldboard intersect and to the right of the shin (Fig. 170). If two or more bottoms are used the center of resistance will be the average of all the centers. For a two-bottom plow it would be halfway between the center of resistance for the two bottoms. On a three-plow outfit it would be at the center of resistance of the

[1] *Am. Soc. Agr. Eng. Trans.*, Vol. XV, p. 150, 1921.
[2] *Jour. Agr. Research*, Vol. XII, No. 4, p. 149, 1918.

middle bottom. Of course, the style of bottom as to shape, type of share, and moldboard will influence the point where all the various forces acting on the bottom will be in equilibrium.

145. Influence of Friction on Design.—After all the above principles are taken into consideration, they resolve themselves into one general principle of plow design that must be considered in every type of plow, no matter whether it be stubble, general-purpose, or sod. That principle is that friction will be the greatest at the point of the share and gradually decrease backward to the end of the moldboard. This can be seen readily on any plow bottom after considerable use. The greatest amount of wear is shown to be at the point; this gradually decreases backward to the tip of the wing of the moldboard. This is why the stubble moldboard, which has a greater amount of curvature, gives better pulverization to the furrow slice. It is also seen that this type of moldboard will pick up the soil quicker and turn it over harder than any other type. That makes this type of plow more adaptable to plowing the loams and the sandy loam soils. The general-purpose moldboard has a smaller amount of curvature than the stubble; it is in this class that the blackland type of plow falls, because its curvature is not so pronounced as that of the stubble moldboard.

146. Influence of Speed on Design.—In the last few years there has been much agitation regarding the designing of plows for high speeds. It is not so difficult to design a plow for high speeds as it is to obtain pulverization. The bottom designed for high speeds must have gradual curves, which approach closely those of the sod type of plow. It can be seen readily that it is not necessary to have the moldboard as wide in this case in order to lift and invert the furrow slice. The higher velocity will carry the soil up over the moldboard, throwing it farther to the side. Much difficulty is likely to result from plows for high speed which must incorporate a plow bottom of long slopes. They may scour well while going at a high rate of speed but when the speed drops to 2 or 3 m.p.h., will they continue to scour at this speed? Will they do the same type of work as at the higher speed?

147. Type of Soil.—Another important factor influencing plow design is the type of soil. In fact, if it were not for the soil factors, designing of plows would be a comparatively simple matter. Brown[1] says:

> The types of soil, from sands, through the loams to the clays, are affected differently by the same plow bottom, and since the prime object of plowing is to put the soil in the proper condition of tilth for the successful growing of crops, it follows that there must be a variety of plow shapes.

[1] *Am. Soc. Agr. Eng. Trans.*, Vol. XIX, p. 24, 1925.

Bacon[1] states, "Plow designers have been obliged to make bottoms that will approach the best work in all conditions under which farmers plow. This accounts for the vast number of different designs of plow bottoms."

DISK-PLOW DESIGN

148. Uses of the Disk Plow.—In certain territories where plowing is extremely difficult, disk plows are used. The conditions adaptable to disk-plow use are enumerated as follows:

1. Sticky, waxy, gumbo, nonscouring soils, and soils having a hardpan or plow sole.
2. Dry, hard ground that cannot be penetrated with a moldboard plow.
3. Rough, stony, and rooty ground, where the disk will ride over the rocks.
4. Peaty and leaf-mold soils where the moldboard plow will not turn the slice.
5. Deep plowing.

149. Angle of Disks.—To meet successfully the conditions outlined, the disks must be so arranged on the frame that they will function properly. From experience it has been found that the disks should be placed at an angle both vertically and horizontally. This angle depends on the proper distribution of the entire weight of the plow, which is necessary to hold the disks in the ground. Weight is required because the disks do not have the suction that the moldboard has. By referring to Figs. 145 and 146, it is seen that the vertical angle can be varied from an abrupt angle to one that is quite flat. The more vertically the disk is set, the greater the tendency to penetrate.

The horizontal angle of the disk influences the width of the furrow slice and the tendency to roll. Disks set more perpendicular to the direction of travel cut wider furrows and do not turn so freely as those set more parallel to the furrow.

150. The Center of Resistance.—The center of resistance on disk plows is closer to the furrow wall than on moldboard plows. Its location is to the left and below the center of the disk. The point varies with the vertical and horizontal angles, the depth, and the amount of concavity of the blade.

151. Disk Sizes and Concavity.—The size of disks for plows ranges from 20 to 38 inches. The average thickness for the disks is $3/16$ inch for the smaller disk and may be as much as $3/8$ inch for the larger disk. The amount of concavity varies with both the different diameters and the same diameter, as shown in the table:

[1] *Am. Soc. Agr. Eng. Trans.*, Vol. XII, p. 26, 1918.

TABLE I.—SIZE, CONCAVITY, AND RADIUS OF THE AVERAGE DISK PLOW[1]

Size, Inches	Concavity, Inches
20	$2\frac{7}{8}$
23	$3\frac{1}{2}$
24	$3\frac{3}{8}$
24	$3\frac{11}{16}$
26	$3\frac{3}{4}$
26	4
26	$4\frac{1}{2}$
28	$4\frac{1}{4}$
28	$5\frac{3}{8}$
32	$4\frac{1}{4}$
32	$6\frac{1}{2}$
38	$6\frac{1}{2}$

[1] *Agr. Eng.*, Vol. VII, No. 5, p. 172, 1926.

CHAPTER XIII

DRAFT OF PLOWS

Plowing is recognized as the greatest labor-consuming operation in the world. There is no doubt that it is the job on the farm that takes the most power. It is important that every effort should be made to reduce this power used to the minimum in keeping with good practice. Davidson gives the following factors which must be considered in determining the actual draft of the plow: "Depth of plowing, width of plow, character of soil, moisture, previous treatment of soil, smoothness of surface, shape of moldboard, sharpness of share, rigidity of plow, and speed.

152. Draft as Affected by Depth of Plowing.—It is almost impossible to make a plow run at a constant uniform depth no matter how well it may be adjusted. Naturally, the deeper the plow penetrates the soil, the more draft there will be. Tests indicate that a 14-inch plow will increase in draft an average of 92 pounds for each inch increase in depth.[1] Taking into consideration the various conditions encountered in the whole United States and the different types of plows used, whether walking, gang, or tractor plow, the average depth of plowing for all these conditions will be around 5 inches. The draft of any plow can be determined by an instrument called a *dynamometer*, which registers the pull or draft of the plow over a measured distance. Then, knowing the rate of travel, the horsepower, as well as the average draft per unit of the cross section of the furrow slice, can be determined.

$$\text{Horsepower} = \frac{\text{force} \times \text{distance traveled in feet per minute}}{33{,}000}.$$

153. Plow Draft as Affected by the Width of the Furrow.—Just as the depth of plowing affects the draft of the plow, the width of the furrow will also affect it. Naturally, the wider the plow, the more soil will be turned over and the more draft there will be. The width of furrow that a plow cuts cannot be controlled absolutely. This is especially true in the walking plow. With the gang plow, however, the bottoms are spaced equally and if the plow is properly adjusted to cut its proper width of furrow and all other factors are working perfectly, each

[1] *Am. Soc. Agr. Eng. Trans.*, Vol. XIV, p. 44, 1920.

bottom will cut a constant uniform width of furrow. It does not follow that each furrow slice will give the same resistance. There are some natural influences that will affect the resistance of furrows. Usually, the draft of the plow is given in the number of pounds pulled per square inch of the cross section of the furrow slice. To determine this, the depth and width of furrow must be considered. The number of square inches in a cross section of a furrow slice can be determined by multiplying the depth by the width of the furrow. That is, a plow going 6 inches deep and cutting the furrow slice 14 inches wide will give a cross-sectional area of 84 square inches. Then, if the total draft for the whole plow is 500 pounds, the draft per square inch would be 500 divided by 84, or 5.95 pounds per square inch.

154. Character of Soil.—The character of the soil, whether it be sandy, clay, loam, or blackland, will have a great deal to do with the number of pounds pulled, or the draft of the plow. A fewer number of pounds is required to pull a plow in sandy soil than in a stiff gumbo or clay soil. The draft of the plow is affected by soil conditions as well as the type of soil and will range from 2 to 3 pounds up to 20 pounds per square inch.

155. Moisture.—The amount of moisture in the soil will also affect the draft or total pounds required to move the plow. The amount of moisture frequently will determine the time when the plowing should be done, whether it should be in the spring or in the fall. When there is a good season, or plenty of moisture in the soil, the draft is not so great as when plowing is attempted when the ground is hard and dry. When the ground is very hard, the plow will not penetrate the soil easily. This, in itself, will indicate that the draft will be increased, owing to lack of moisture.

156. Previous Treatment of the Soil.—The draft of the plow will be influenced to a considerable extent by the previous treatment to which the soil has been subjected; that is, whether it has been properly plowed and cultivated, whether the crop planted on the soil before was cultivated, whether it was harrowed by a disk harrow before being plowed or was allowed to go untreated. The amount of straw and organic matter that may have been covered by a previous plowing will also affect the draft because organic matter will cause the soil to become mellow and break up easier.

157. Smoothness of Surface.—If the surface of the soil is uneven, naturally the water will collect in the low places and leave the high places without the required amount of moisture. Then, of course, when the plow comes to the moist places it will plow easier than where there is a lack of moisture, so that the draft is affected directly from the unevenness

of the ground. If the plow is a gang plow of the unit type and the surface is not even, some of the plows will go much deeper than others, causing an overload. Up and down hill causes heavy draft one way and light the other.

TABLE II.—DRAFT REQUIREMENTS FOR VARIOUS PLOWING CONDITIONS AND SIZES OF PLOWS

Kinds of soil and depth of plowing	Number and size of plows				
	1 14-inch	2 16-inch	3 16-inch	4 14-inch	5 14-inch
Sandy soil 6″ deep or corn stubble 5″ deep	210	480	720	840	1,050
Sandy soil 8″ deep or wheat stubble 5″ deep	280	640	960	1,120	1,400
Corn stubble 8″ deep or wheat stubble 6″ deep	336	768	1,152	1,344	1,680
Wheat stubble 8″ deep	448	1,024	1,536	1,792	2,240
Clay soil 5½″ deep	616	1,408	2,112	2,464	3,080
Gumbo 5″ deep	1,400	3,200	4,800		

TABLE III.—DRAFT PER SQUARE INCH OF FURROW

Kind of Soil	Pounds of Draft per Square Inch of Furrow Section
Sandy soil	3
Sandy loam	3 to 6
Silt loam	5 to 7
Clay loam	6 to 8
Heavy clay	7 to 10
Gumbo	15 to 20

158. Shape of Moldboard.—As has already been indicated, the draft of the plow will be affected by the shape of the moldboard, whether stubble, general-purpose, blackland, or sod. The tests run by Ocock[1] indicate, to some extent, the difference of draft as affected by the shape of the moldboard. The results of his tests show that the stubble moldboard gives a greater draft than the sod moldboard, and the general-purpose comes in between these. His conclusions were that the more abrupt the curve, the greater the draft. The less curvature there is to the moldboard, the less the pulverizing action upon the furrow slice and, naturally, the less pressure will be exerted upon the surface of the moldboard, resulting in less draft. Collins[2] found, in his tests at Ames, Iowa,

[1] *Am. Soc. Agr. Eng. Trans.*, Vol. VI, p. 13, 1912.
[2] *Am. Soc. Agr. Eng. Trans.*, Vol. XIV, p. 39, 1920.

that the type of bottom did not materially influence the draft; than an increase in speed produced about the same increase in draft with any type of bottom. Upon analyzing the results, it is shown that a sod bottom has a long section of furrow slice which is carried on the share and moldboard and which must be pushed off. The greater area in contact results in a corresponding increase in frictional resistance and draft.

159. Sharpness of Share.—The share must cut the furrow slice loose from the ground, and a large percentage of the draft of the plow results from cutting the furrow slice loose. As a result of some tests Collins[1] made to determine the draft necessary for cutting and turning the furrow slice, and the draft of the plow alone, he has the following to say: "The draft of the plow on the ground, 18 per cent; draft due to turning furrow slice, 34 per cent; draft due to cutting slice, 48 per cent."

Thus it is seen that practically 50 per cent of the total draft of the plow is used in cutting the furrow slice. A test was run to determine the effect of dull shares and sharp shares upon the draft of the plow. In a test on sandy loam soil the difference in draft of a sharp share was almost negligible. In a field of bluegrass sod there was a difference of 14 per cent in favor of the sharp share. In soil that is soft and mellow the sharpness of the share will not matter so much, but if there are many roots or if the soil is comparatively hard or lacks moisture, a sharp share is to be advocated.

160. Hitch.—The angle of hitch will also affect the draft of the plow. If the angle is short and sharp and the implement hitched close to the point of power, there will be a tendency to lift the plow, which will take some of the weight of the plow off the ground and slightly decrease the draft. The reverse will be true if the hitch is farther away.

161. Rigidity of Plows.—Some plows may not be constructed rigidly enough to secure a uniform depth of penetration and a uniform width of furrow. It is important that they should be, because of the effect that the depth and width of the furrow will have upon the draft of the plow.

162. Speed.—Some tests have been made to determine the effect of speed on the draft of plows. All these tests have shown conclusively that there is an increase in draft as the speed increases. The results of the tests made in California by Davidson, Fletcher, and Collins[2] were as follows: "In clay loam speed 1 m.p.h.—draft, 100 per cent. Speed 2 m.p.h.—draft 100 to 114 per cent. Speed 3 m.p.h.—draft 128 per cent. Speed 4 m.p.h.—draft 142 per cent." Tests in Iowa black-loam soil gave the following results: "Speed 1 m.p.h.—draft 100 per cent.

[1] *Am. Soc. Agr. Eng. Trans.*, Vol. XIV, p. 39, 1920.
[2] *Am. Soc. Agr. Eng. Trans.*, Vol. XIII, p. 69, 1920.

Speed 2 m.p.h.—draft 117 per cent. Speed 4 m.p.h.—draft 126 per cent."

The conclusions were that an increase of the field speed of a plow with a general-purpose moldboard, from 2 to 3 m.p.h. resulted in an increase of draft from 8 to 12 per cent, varying with the soil. Doubling the speed will result in an increase of draft from 16 to 25 per cent. The amount of work accomplished is increased from 50 to 100 per cent, respectively. It is to be remembered that practically 50 per cent of this task of plowing is consumed in cutting the furrow slice. The conclusions reached by Collins in his tests in Iowa in 1920 were that the increase in draft, due to speed, is applied to that part of the total which is required for turning and pulverizing. This varies with the speed from less than one-third to about one-half the total draft of the plow within a range of 2 to 4 m.p.h.

TABLE IV.—RATE OF TRAVEL

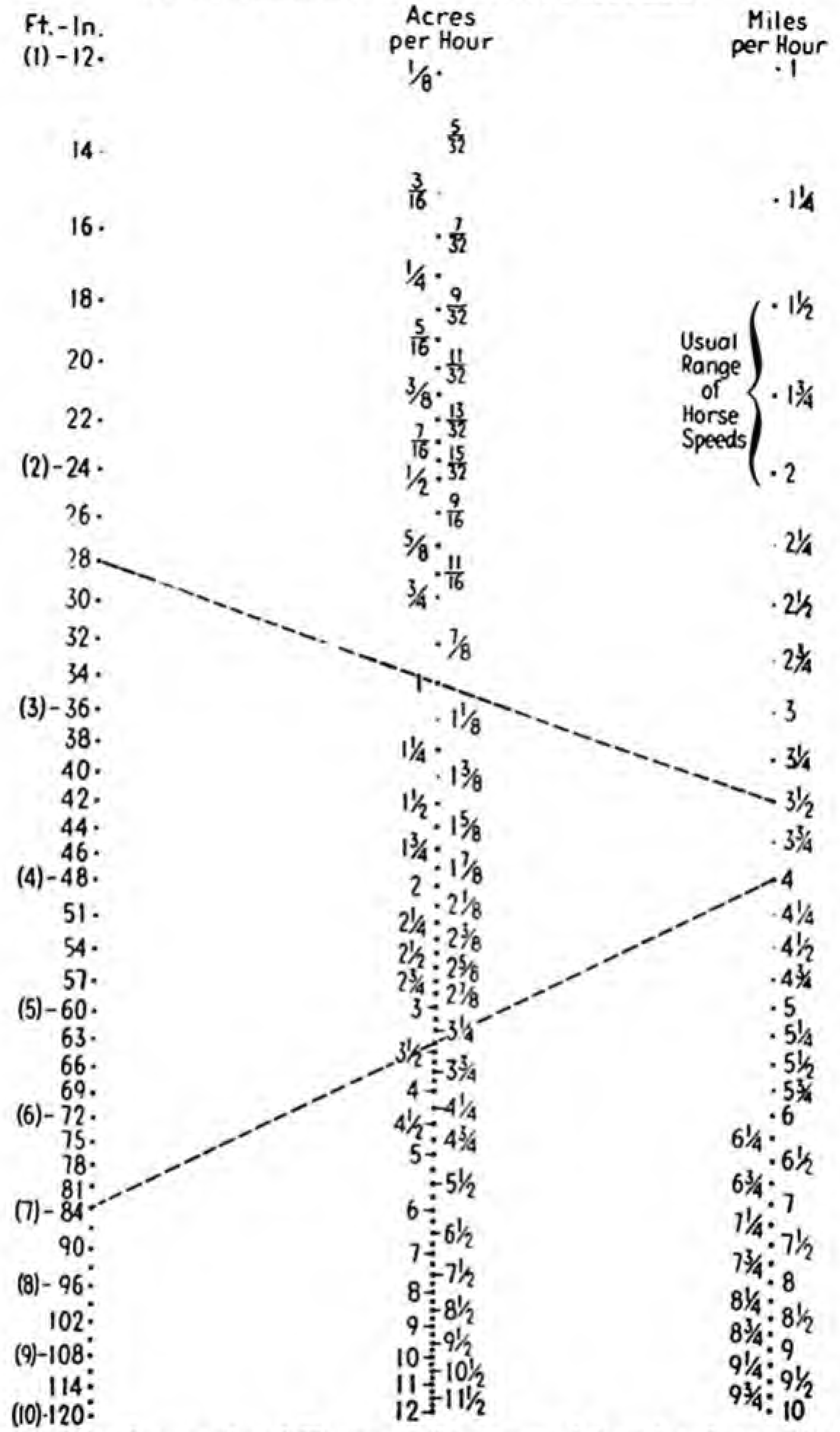
Miles per hour	Feet per minute	Miles per hour	Feet per minute
1	88	4	352
1¼	110	4¼	374
1½	132	4½	396
1¾	154	4¾	418
2	176	5	440
2¼	198	5¼	462
2½	220	5½	484
2¾	242	5¾	508
3	264	6	528
3¼	286		
3½	308		
3¾	330		

Studies made in Ohio by Ashley, Reed, and Glaves[1] indicated that with two bottoms the average increase in draft due to increased speeds was 1.17 pounds per square inch of furrow slice for each mile per hour increase in speed.

163a. Rate of Plowing.—One 14-inch plow bottom pulled at the rate of 2½ m.p.h. will plow approximately 11/32, or 0.3, acre in 1 hour. Some time, however, must be allowed for turning, which will depend on the shape and size of the field and how it is laid out. For example, with a two-plow outfit in a field 80 rods long, where lands of average width are struck out and the turning is done on headlands, about 6 per cent of the time is spent in turning at the ends. Table V shows the acreage plowed with plows of different width when drawn at different speeds.

[1] Progress Report on Draft of Plows Used for Corn Borer Control, U. S. Dept. Agr., Bur. Agr. Eng., 1932.

TABLE V.—CHART SHOWING ACRES COVERED PER HOUR WITH DIFFERENT WIDTHS OF IMPLEMENTS AT VARIOUS SPEEDS[1]



[1] Copyrighted, 1933, by International Harvester Company of America, Inc. (Used by special permission of the company.)

A four-plow outfit, of course, will accomplish about twice as much as the two, if both are run at the same speed; and a six-plow outfit twice as much as the three-plow outfit. One acre contains 43,560 square feet, or 160 square rods. A 14-inch furrow 1 mile long equals 6,160 square feet.

163b. Draft as Affected by Attachments.—Ashley, Reed, and Glaves[1] found that two 10-foot wires increase the draft about 2 per cent, an ordi-

[1] Progress Report on Draft of Plows Used for Corn Borer Control, U. S. Dept. Agr., Bur. of Agr. Eng., 1932.

nary jointer absorbs about 7 per cent of the power when used with a coulter, and the jointer alone requires less power than a combination coulter and jointer. They found that the covering wires, coulter, and jointer together absorb between 10 and 15 per cent of the total power required to pull the plow with attachments.

164. Effects of Grades.—When on a grade, the effective drawbar pull of a tractor is lessened 1 per cent for each per cent of grade. For example, the weight of the tractor ready for work with an operator and a three-bottom plow is approximately 7,600 pounds. To negotiate a 10 per cent grade with this outfit would require an additional power equivalent to a pull at the drawbar of 760 pounds.

165. Other Factors Affecting the Draft of Plows.—Scouring of plows will influence the draft. If there is a smooth, polished surface for the soil to slip over, it is obvious that there will be less friction and draft.

The weight of the implement cannot be overlooked. A heavy bulky machine will pull heavier than one that is light.

166. Draft of Disk Plows.—The disk plow is slightly lighter in draft than the mold board, when plowing under similar conditions and turning

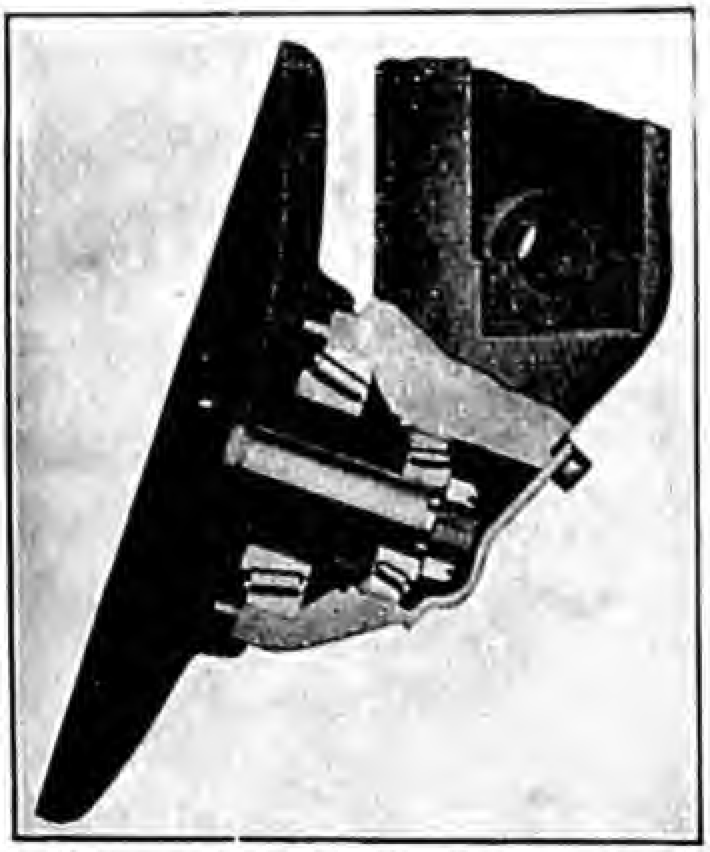


FIG. 166.—Cross section of roller bearing for disk plow.

the same volume of soil. The type of soil is the greatest external factor to consider in the draft of any plow. In very hard ground, it is often necessary to add weight to the wheels to force the plow into the soil. Of course, the added weight will create more draft.

Factors incorporated in the plow are very important. The bearings of the disk-plow blade affect the draft. According to tests conducted by Hardy,[1] a plain cone bearing will pull 23 per cent heavier than a ball

[1] HARDY, E. A., Univ. Saskatchewan, Saskatoon, Canada.

or roller bearing. Figure 166 shows a roller bearing, and Fig. 167 shows a plain cone bearing.

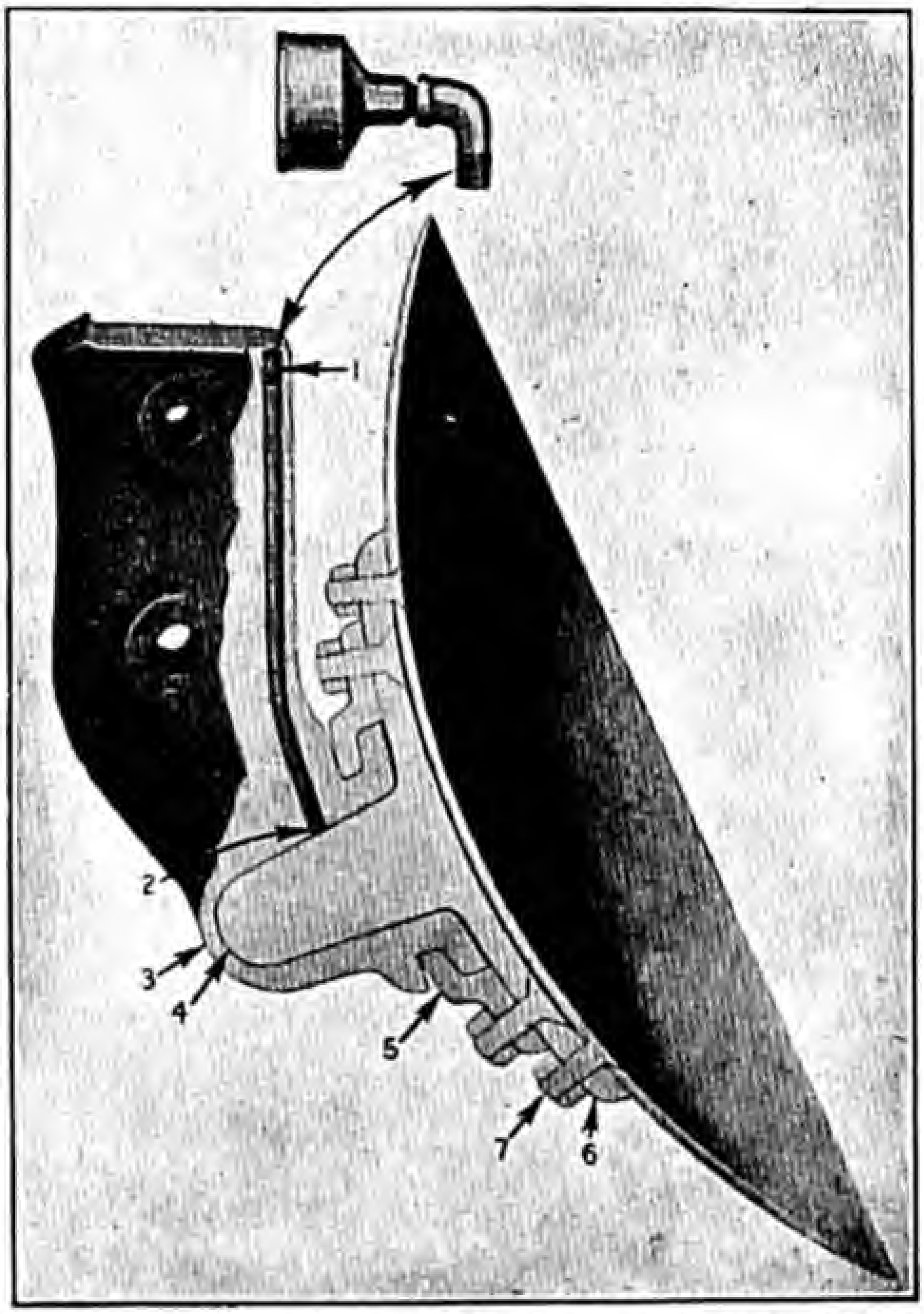


FIG. 167.—Cross section of cone-type disk-plow bearing: 1, point where grease cup is attached; 2, oil tube; 3, cup for cone; 4, cone; 5, flange to hold bearing in place; 6, disk casting to hold disk blade; 7, bolt to hold disk blade.

The type of scraper used to clean the disk will also affect the draft. Hardy's tests indicate that the revolving type gave slightly less draft than the spade type.

CHAPTER XIV

PLOW HITCHES, TROUBLES, LAYING OUT FIELDS FOR PLOWING, DUTY, DEPTH, LIFE, CARE, AND COST OF PLOWING

Next in importance to the problem of making a plow that will work under average conditions is the problem of hitching the plow to the prime mover, or the power that is to operate it. The hitching of horses requires different arrangements from that of tractors. The same principles are involved, but they must be handled differently. The problem is to get all the pulling forces of the power and the resistance forces of the load in equilibrium, both vertically and horizontally.

PLOW HITCHES

The hitch is composed of the parts connecting the plow with the power. It may be simple, consisting of only one or two parts, or it may consist of a multiplicity of bars, braces, angles, and levers arranged to absorb certain vertical and horizontal forces.

167. Center of Pull.—The center of pull is often described as the *true point of hitch,* or *center of power.* Whatever the term used, the point referred to is the center of the power, which is chiefly horizontal, but the vertical forces must also be considered.

On a tractor this is the point where the drawbar is attached, which is always the middle of the tractor halfway between the wheels. In most tractors the drawbar can be shifted sidewise to compromise with the hitch on the tool. If horses are used, the center of power with one horse is midway between his shoulders or hame tugs (Fig. 168). If two horses are used, the center of power will be halfway between the two animals.

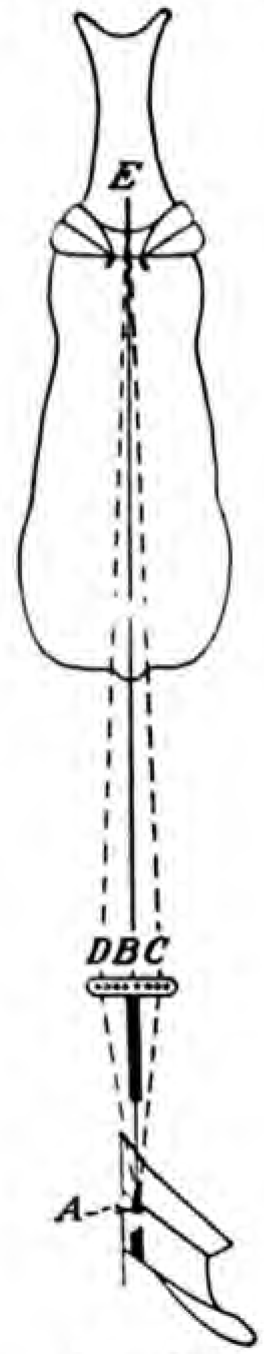


FIG. 168.—The center of the pull should be directly ahead of the center of the load.

168. Center of Load or Resistance.—The center of load is often termed the *center of draft.* As shown in Fig. 169, this is the point within the plow about which all the forces acting on the plow are balanced.[1] A simple

[1] *Agr. Eng.,* Vol. 17, No. 1, p. 5, 1936.

rule to find the center of load for two or more bottoms is to find the total width of cut. Divide the result by two to find the center of cut. Add to this figure one-half the width of cut of one bottom.

169. Line of Hitch.—The line of hitch or line of draft is an imaginary straight line passing from the center of load or resistance through the clevis or hitch to the center of power where the hitch is attached to the power. This definition applies to both the vertical and horizontal adjustment.

170. Side Draft or Offset Pull.—Side draft or offset pull is produced when the center of load or resistance is not directly behind the center of

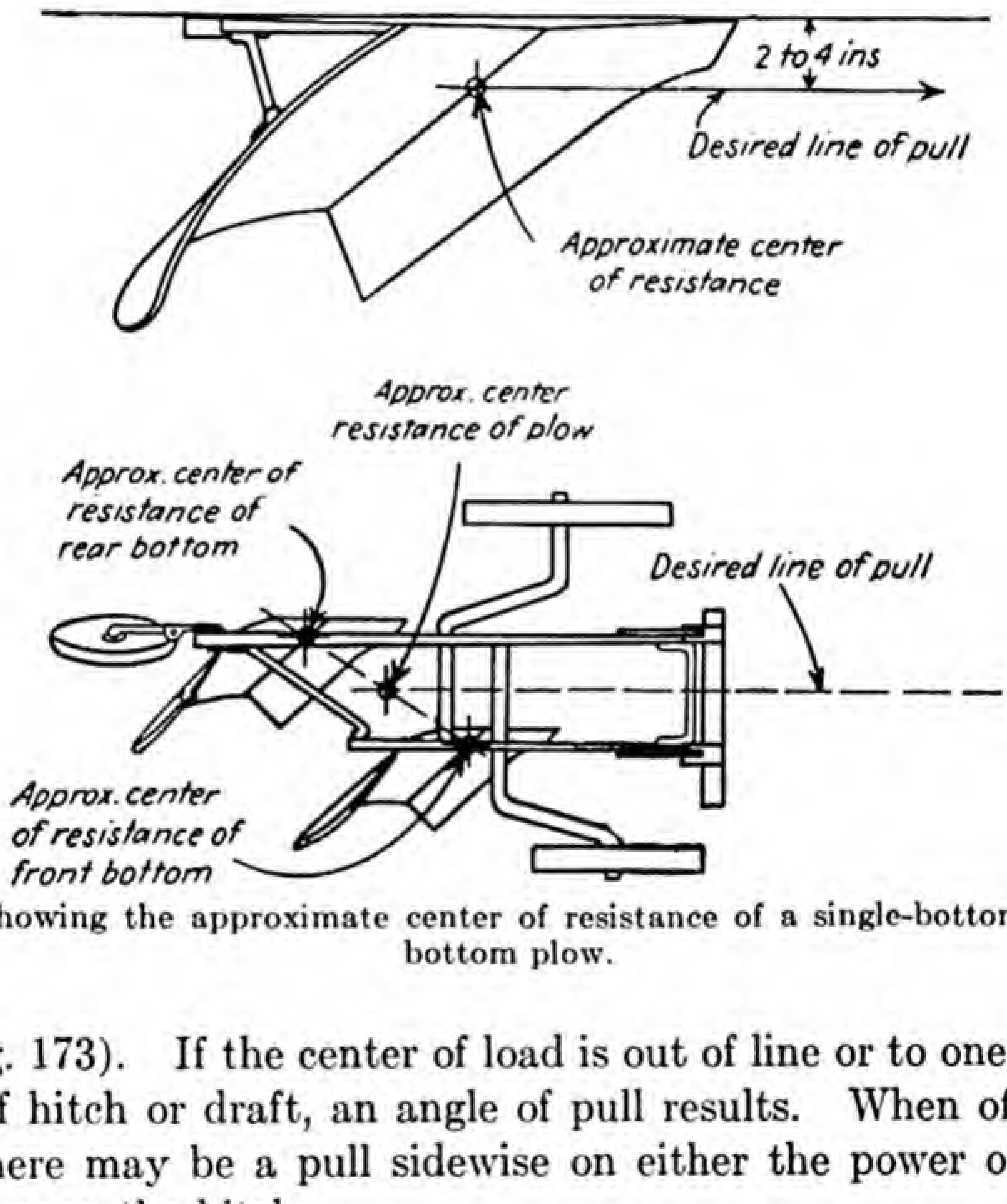


FIG. 169.—Showing the approximate center of resistance of a single-bottom and a two-bottom plow.

power (Fig. 173). If the center of load is out of line or to one side of the true line of hitch or draft, an angle of pull results. When offset pull is present, there may be a pull sidewise on either the power or the load, depending upon the hitch.

It is a difficult problem to hitch a single-bottom plow attached closely to a fairly wide tractor. The center of pull and the center of load are so close together longitudinally and so much out of line horizontally that a good hitch is hard to obtain. In such a case the plow is put farther back, and some of the side forces are taken care of with a long landside and rear furrow wheel. Moving the plow farther back reduces the angle of pull with a wide power unit.[1]

[1] *Agr. Eng.*, Vol. 15, No. 11, p. 387, 1934.

171. Vertical Adjustment of Horse Hitches.—With the horse as a source of power, the proper arrangement for the hitch is that one along a straight line extending from the center of resistance (Fig. 170) through the clevis *C* to the point *E* where the tugs are fastened to the hames. This should be the proper adjustment vertically. If the hitch at the clevis is too high, as *B*, the tendency will be to throw the plow deeper into the soil because of the fact that the line of hitch is seeking the straight line just mentioned. The reverse action will be true if the hitch is lowered to *D* below that of a straight line. This principle applies to all horse-drawn plows from walking to gang, and also to tractor-drawn plows, both moldboard and disk.

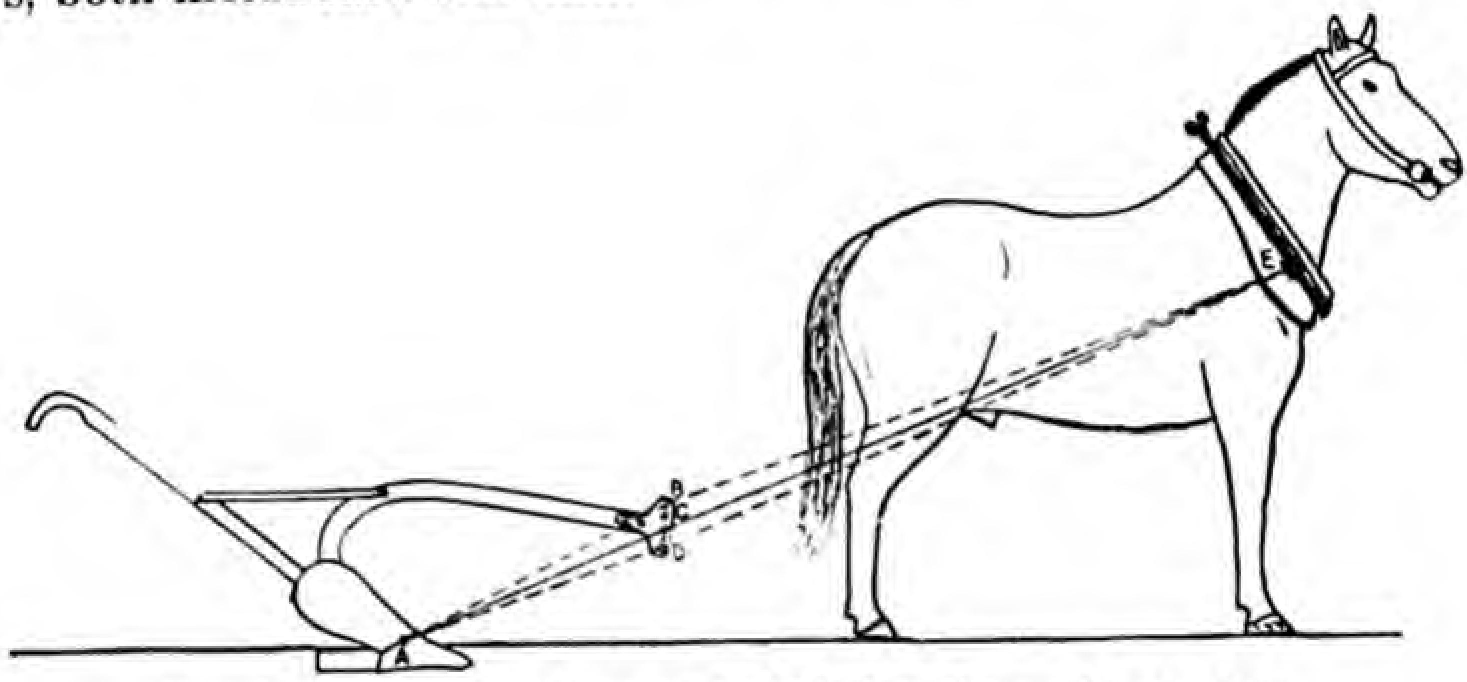


Fig. 170.—Vertical adjustment of hitch on horse-drawn plow.

172. Horizontal Adjustment of Horse Hitches.—To hitch the plow to make it take the proper furrow width, the center of load or resistance must also be considered. A straight line must pass from the center of load through the clevis to the center of pull between the tugs (Fig. 168). If the plow bottom is in perfect condition and the hitch properly adjusted, the ordinary walking plow should operate with very little assistance from the operator. When three or more horses are used, the hitch problem is greatly increased because the right-hand horse walks in the furrow throwing the other two upon the unplowed land so that the center of power does not coincide with the center of load, thus creating offset pull.

173. Tractor Hitches for Moldboard Plows.—With the advent of the tractor to furnish power for pulling farm tools, the problem of hitching in such a manner as to eliminate offset pull on both the plow and the tractor must be studied. Plow designers have worked out many different arrangements, but the hitch in general use is of the type shown in Figs. 173 and 174. Of course, there are many variations of this type of hitch, differing only in the way the parts are fitted together and means of adjustment.

Tractor hitching, like horse hitching, is a question of hitching in such

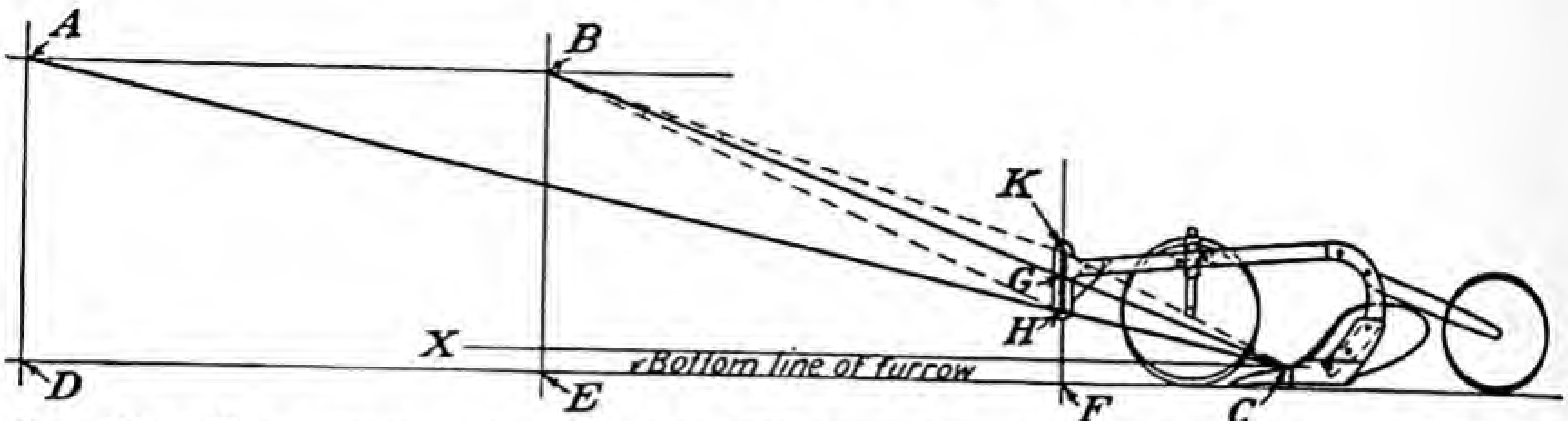


FIG. 171.—The correct vertical hitch is *BGC* for a short hitch and *AHC* for a long hitch.

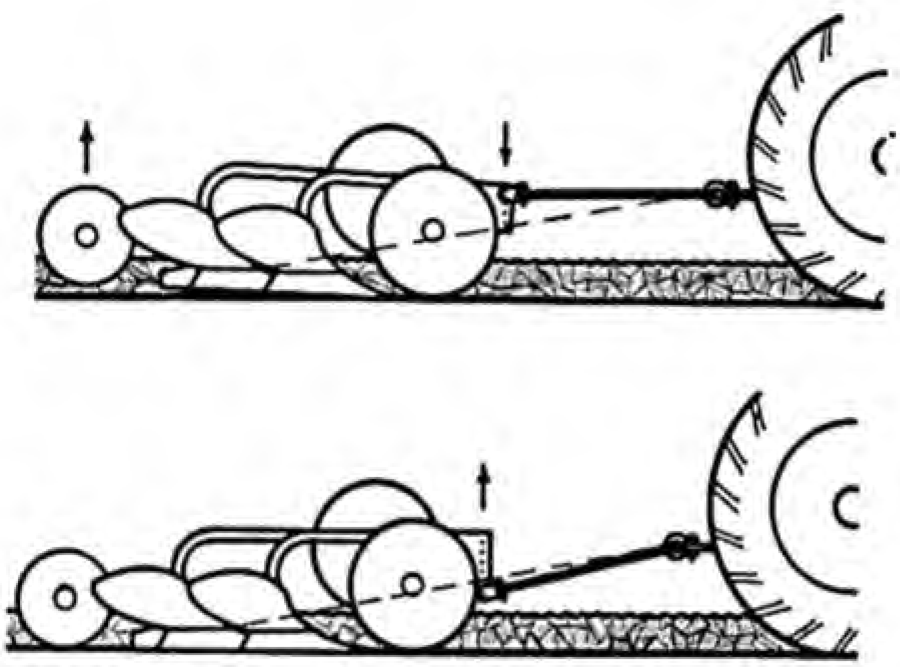


FIG. 172*a*.—Showing effect on plow when hitch at clevis is too high (*top*) and too low (*bottom*).

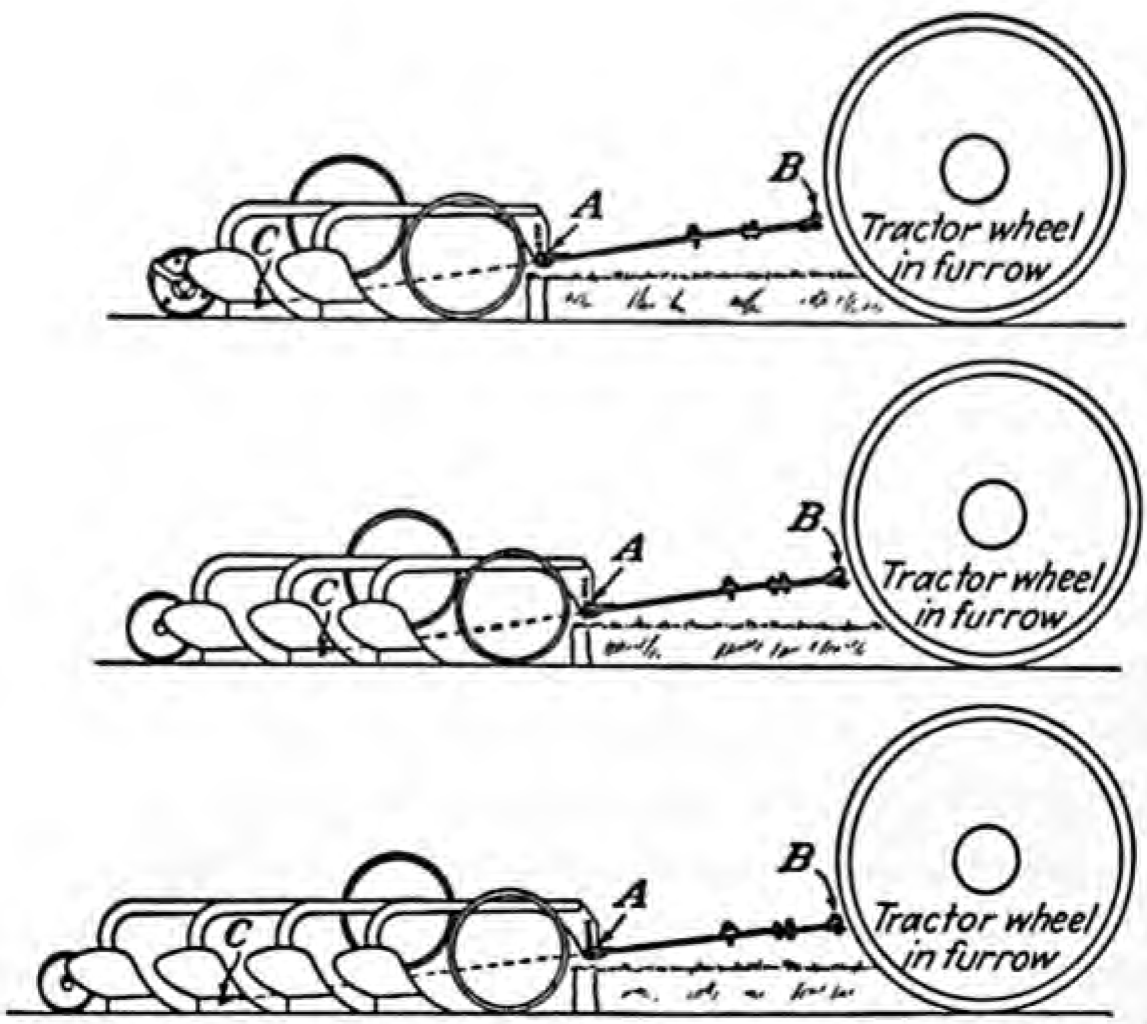


FIG. 172*b*.—Vertical hitch adjustments for two-, three-, and four-bottom moldboard plows.

a way that there will be no offset pull—at least as little as possible. So again it is necessary to have the center of pull and center of load coincide with the line of hitch—both vertically and horizontally.

Figure 171 shows the correct vertical adjustment for a tractor and plow when the line of hitch is *BGC*. If the hitch at the clevis were raised to *K*, there would be a tendency for the pull to seek the true line of hitch, and, consequently, there would be a downward force at *K*, causing extra weight on the front wheels of the plow and relieving the rear wheel of a part of its load. If the hitch were changed to *H*, part of the weight of the plow would be supported by the tractor. The extra pressure would be transferred to the rear wheel.

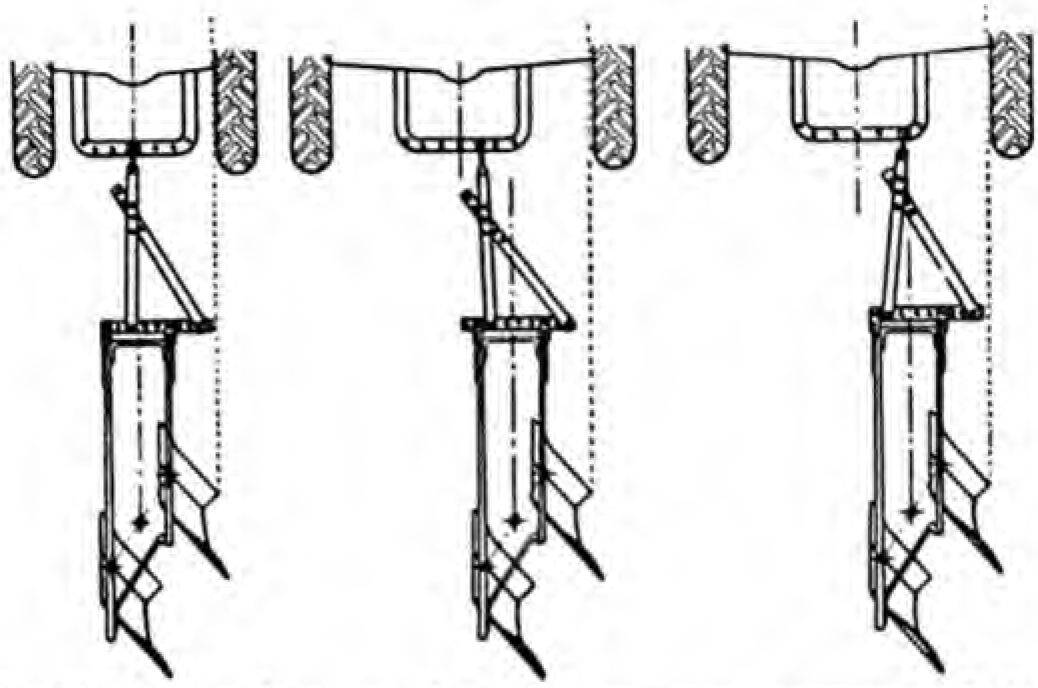


FIG. 173.—Hitching a two-bottom plow to a row-crop tractor. *Left*, correct hitch for narrow setting of wheels; *center*, when the tractor wheels are set wide the best hitch is about midway between the center of the tractor and the center of resistance of the plow; *right*, this arrangement of hitch places all the side draft on the tractor.

Figures 172*a* and 172*b* show vertical hitch adjustments for two-, three-, and four-bottom moldboard plows. When the hitch is too high at *A*, the front of the plow is forced down and there is a tendency for the rear of the plow to rise up. When the hitch is too low at *A*, the front of the plow is partially lifted.

Figure 173 shows horizontal methods of hitching a two-bottom plow to a row-crop tractor. With most of the smaller outfits, it is necessary to run the right wheels of the tractor in the furrow in order to bring the center of pull over as far as possible in front of the center of load. This greatly reduces the angle of pull and the offset pull.

174. Hitching Trailing Moldboard Plows to the General-purpose Tractor.—When the rear wheels of a general-purpose or row-crop-type tractor are wide apart, it is difficult to balance the center of pull and the center of load of the plow. Table VI shows that when three 14-inch bottoms, cutting a strip 42 inches wide, are hitched to a tractor with a tread of 64 inches, the center of pull is 32 inches to the left of the center of the

TABLE VI.—DATA SHOWING HOW TO SET MOLDBOARD-PLOW HITCHES FOR THE GENERAL-PURPOSE TRACTOR WITH ADJUSTABLE TREAD

Number of bottoms	Width of bottom, inches	Width of cut, inches	Distance from center of load of plow to furrow wall, inches	Distance from center of tractor to center of 12-inch tractor tire, inches	Tractor wheel tread required to pull plow in true line of hitch, inches
1	16	16	14	20	40
2	12	24	16	22	44
2	14	28	19	25	50
2	16	32	22	28	56
3	12	36	22	28	56
3	14	42	26	32	64
3	16	48	30	36	72
4	14	56	33	39	78

The center of resistance for all bottoms is considered to be 2 inches from the edge of the shin.

right tractor tire. Assume that the inside side of a 12-inch tire just touches the furrow wall; deduct one-half the diameter, or 6 inches, from the 32 inches; then the distance from the furrow wall to the center of pull of the tractor is 26 inches, which is also one-half the width of cut or the center of load of the plow. If, however, two 14-inch bottoms are hitched to the tractor with a 64-inch tread, the center of pull will be 8 inches to the left of the center of load of the plow, or in other words, there will be 8 inches of offset pull. The effect of this 8-inch offset pull can be largely offset by dividing it between the tractor and the plow by moving

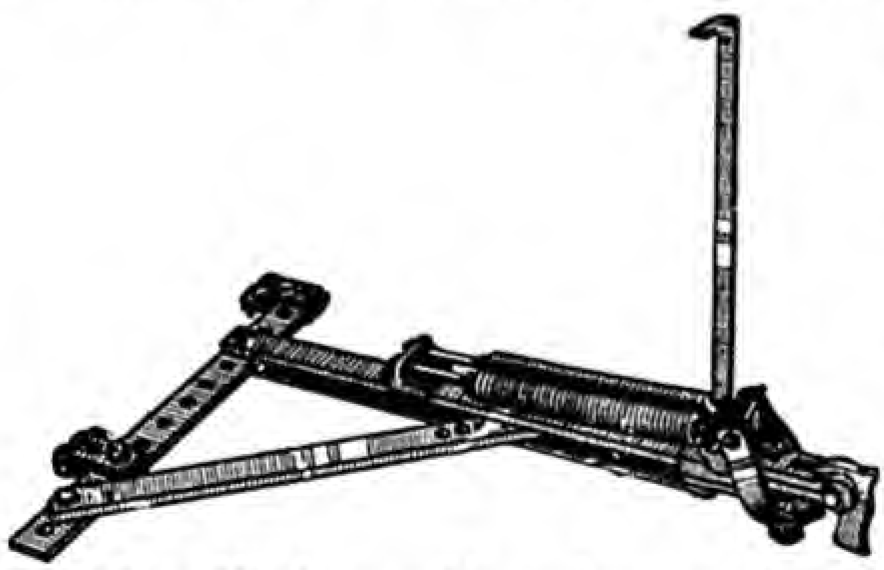


FIG. 174.—Hitch assembly and spring release for moldboard plows.

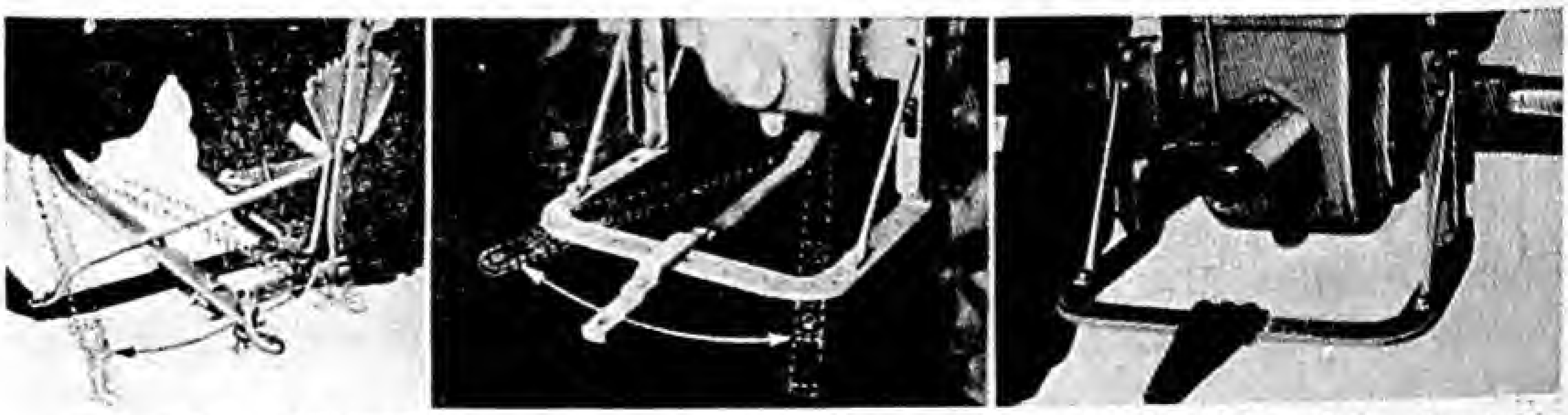


FIG. 175.—Different drawbar equipment which aids in plow hitching: *left*, adjustable drawbar useful for plow on hillsides; *center*, swinging drawbar permits short turns; *right*, drawbar extension also helps in making short turns.

the point of hitch on the drawbar about one hole, or 2 inches, which moves the hitch on the plow slightly to the left, or by adjusting the brace arm of the plow hitch, which reduces the angle of pull. A wide tractor tread and a small plow result in a greater angle of pull, thereby creating more offset pull.

175. Tractor Plow Hitches for Disk Plows.—The principles of hitching moldboard plows are also applicable in hitching trailing disk plows. However, different hitch adjustments are necessary to obtain correct vertical and horizontal hitching.

The vertical hitch is quite simple, as the hitch bar can be adjusted up and down on the plow so there will be a straight line from the tractor

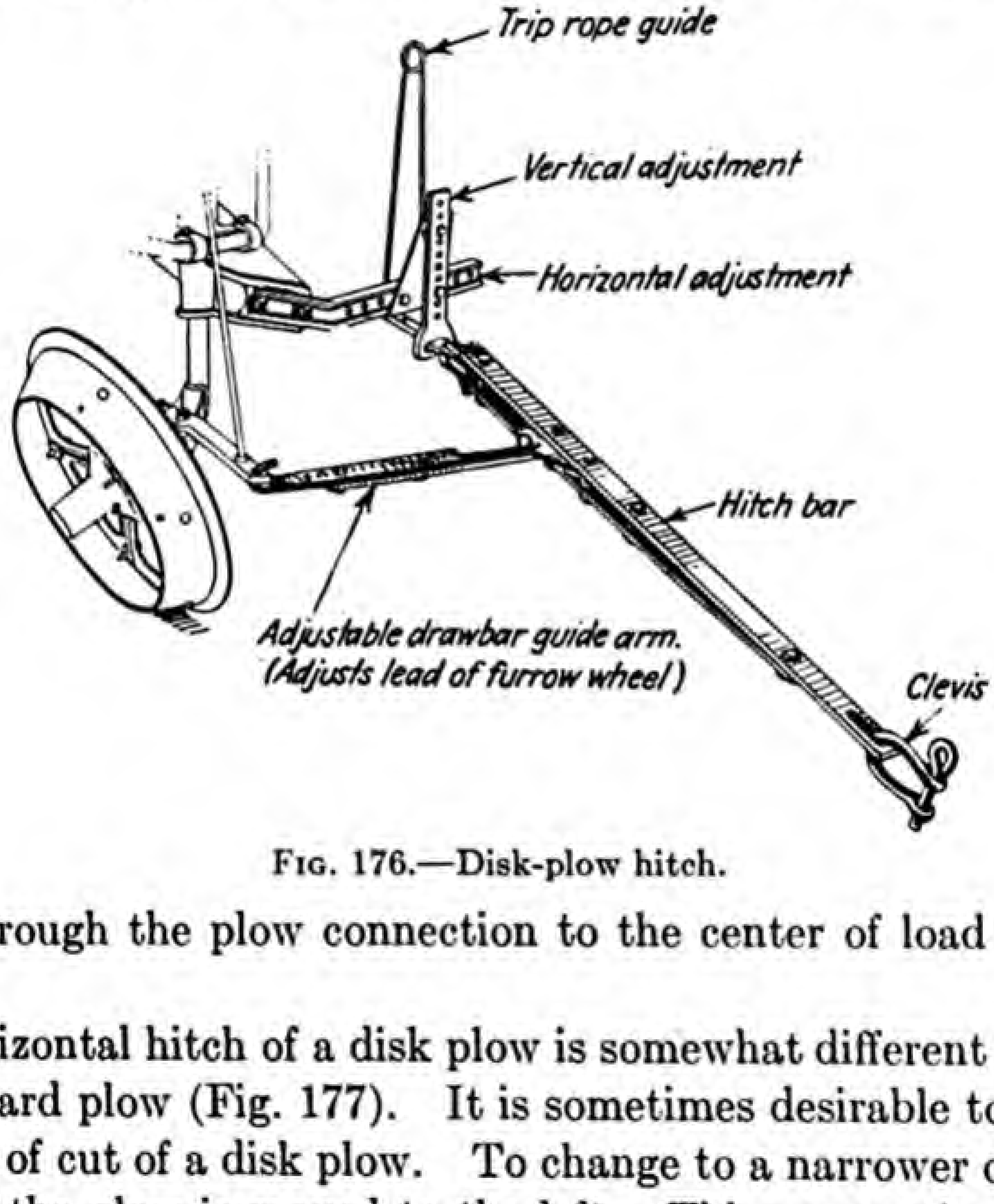


Fig. 176.—Disk-plow hitch.

drawbar through the plow connection to the center of load of the plow (Fig. 176).

The horizontal hitch of a disk plow is somewhat different from that of the moldboard plow (Fig. 177). It is sometimes desirable to change the total width of cut of a disk plow. To change to a narrower cut the hitch on front of the plow is moved to the left. This causes the front of the plow to move to the right and the rear to swing to the left (facing the front of the plow), causing the disks to fall more in line or to *trail*. Since the front furrow wheel is held in position by a guide arm (Fig. 176) connected to the hitch bar, it is necessary to adjust this arm whenever the hitch bar is moved either to the right or to the left. To change to a wider cut the hitch bar is moved to the right on the plow. This will cause the rear of the plow to swing to the right so that each of the disks cuts more. The front of the plow is held in position by giving the front furrow wheel a lead toward the furrow wall.

Hitching the plow to a swinging tractor drawbar may also aid in adjusting the disk-plow hitch. Figure 180 shows how a chain is used in connection with a disk-plow hitch.

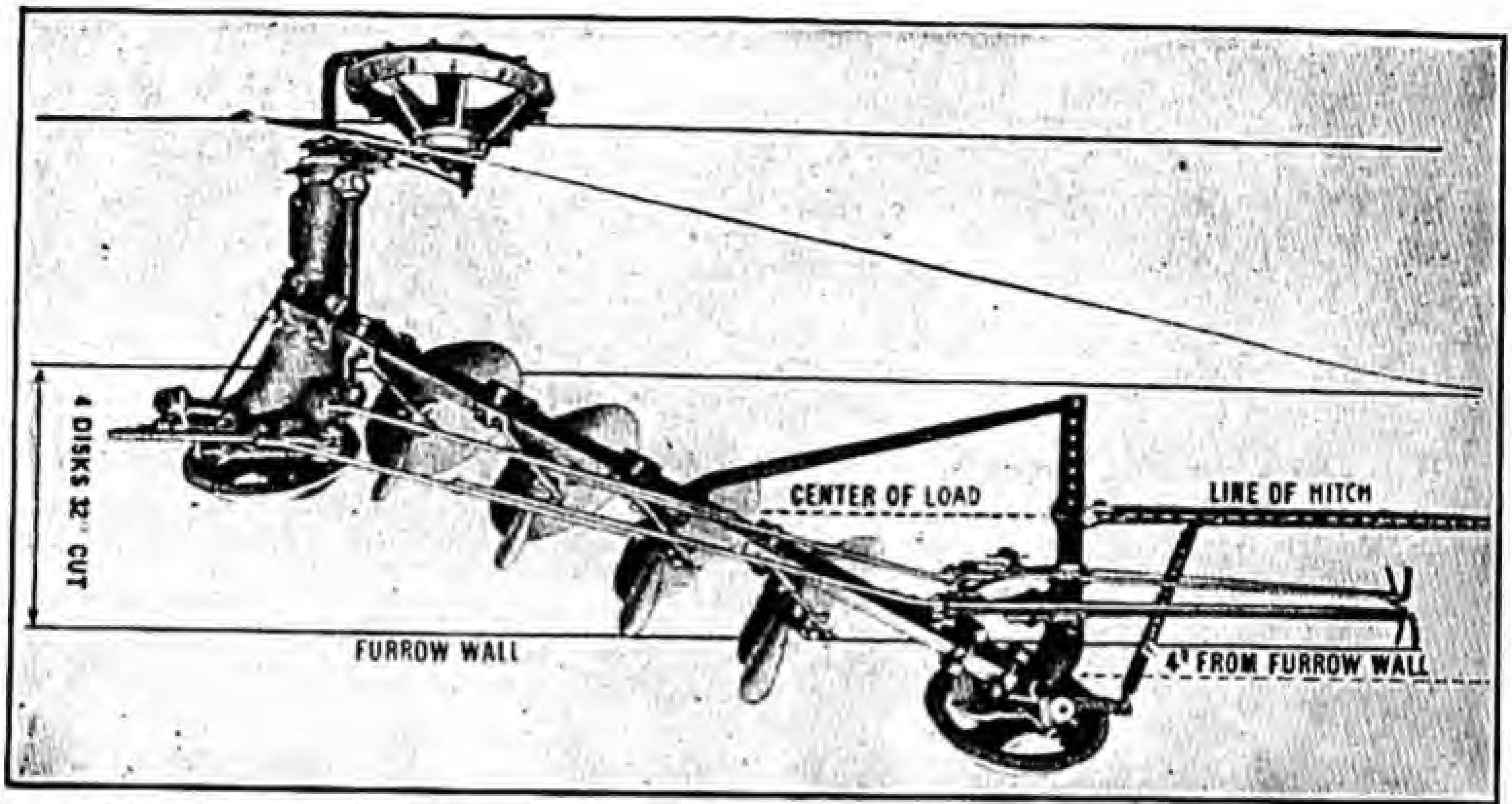


FIG. 177.—Illustration shows a four-disk tractor plow, each disk cutting 8 inches, making the total cut of the plow 32 inches. One-half the total cut, measured from top of furrow wall, is 16 inches, or the center line of draft on this plow. The center of cut is always the line of draft on a disk plow.

Wide harrow-plows require a different hitch arrangement than the regular disk plow. Figure 178 shows a typical hitch for this type of plow. It is seen that in addition to the front hitch bar and connection to the front furrow wheel a rigid connection is extended back to the middle and

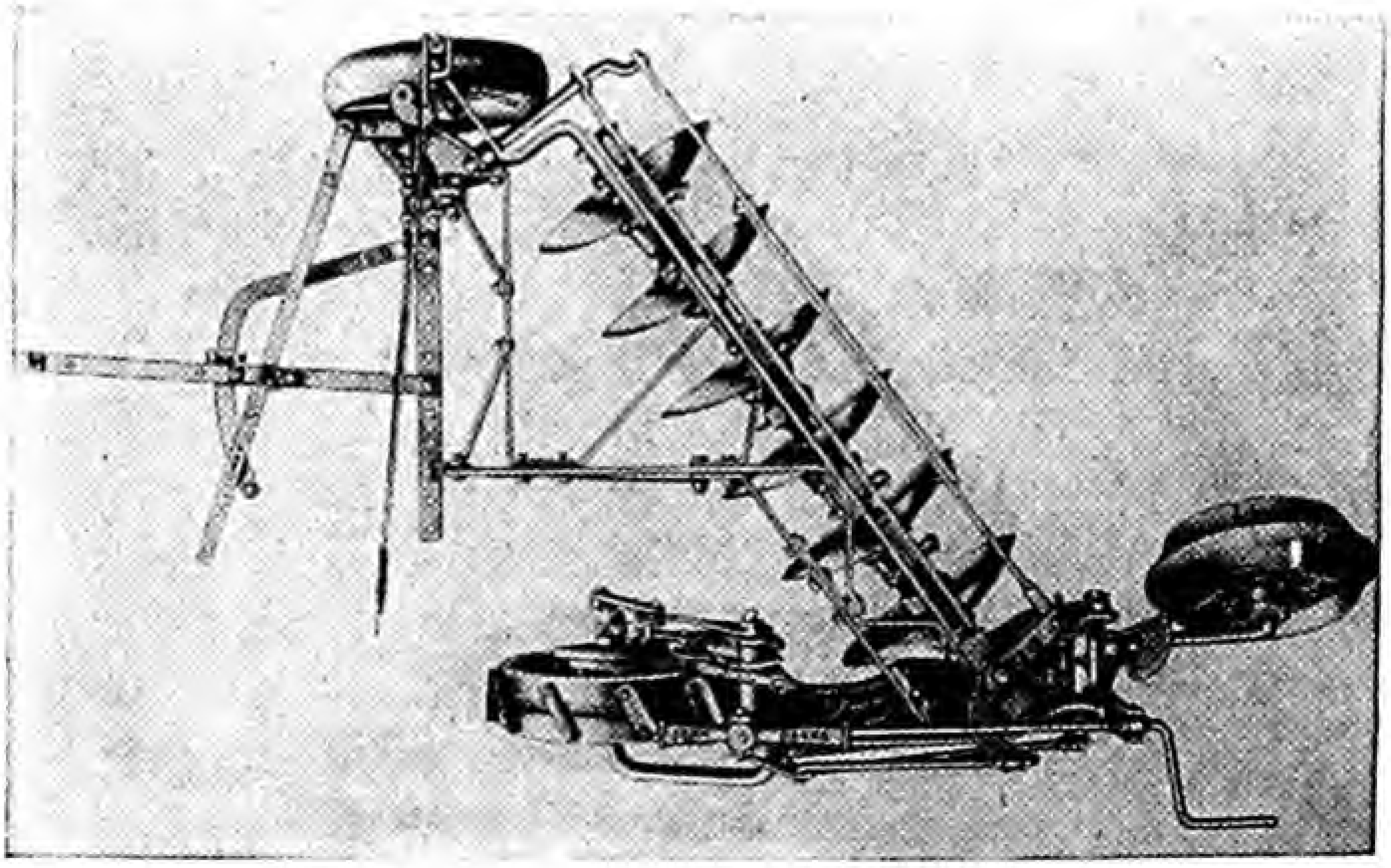


FIG. 178.—Hitch for harrow-plow.

rear end of the plow to keep the disks from trailing. Figure 179 shows an arrangement for hitching three harrow-plows in tandem.

Figure 178 shows a typical hitch for a harrow-plow. This type of

plow usually cuts a wider strip than the regular disk plow and therefore requires a different hitch arrangement.

176. Hitch Spring Releases and Stops.—Much damage to the plow often results when a hidden stone or root is hit by the plow.

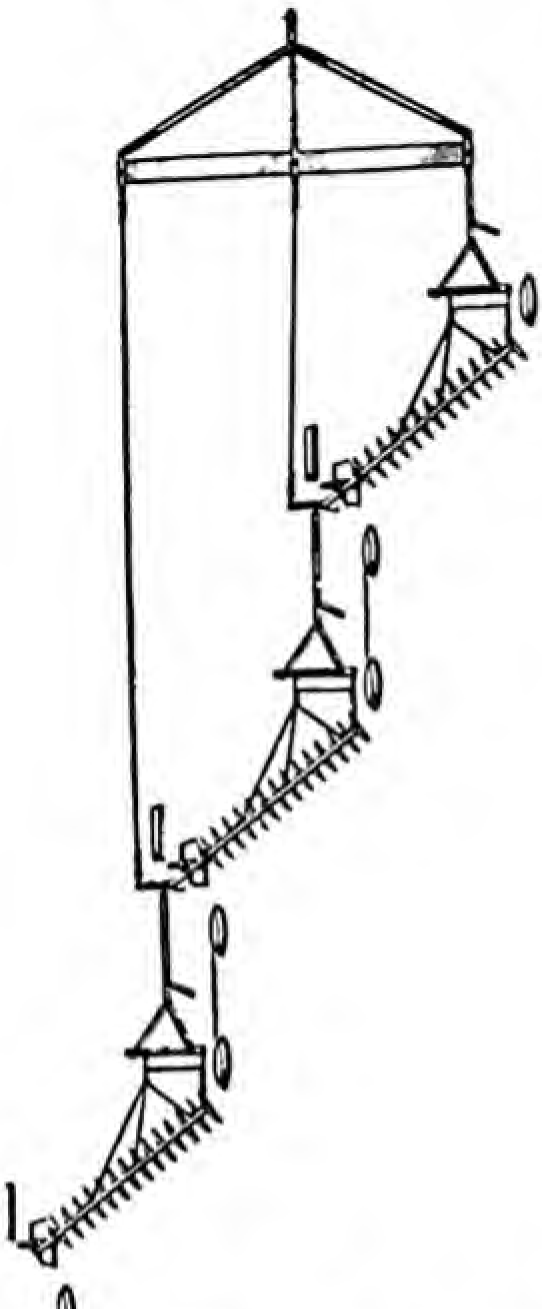


FIG. 179.—Tandem hitch for harrow-plows.

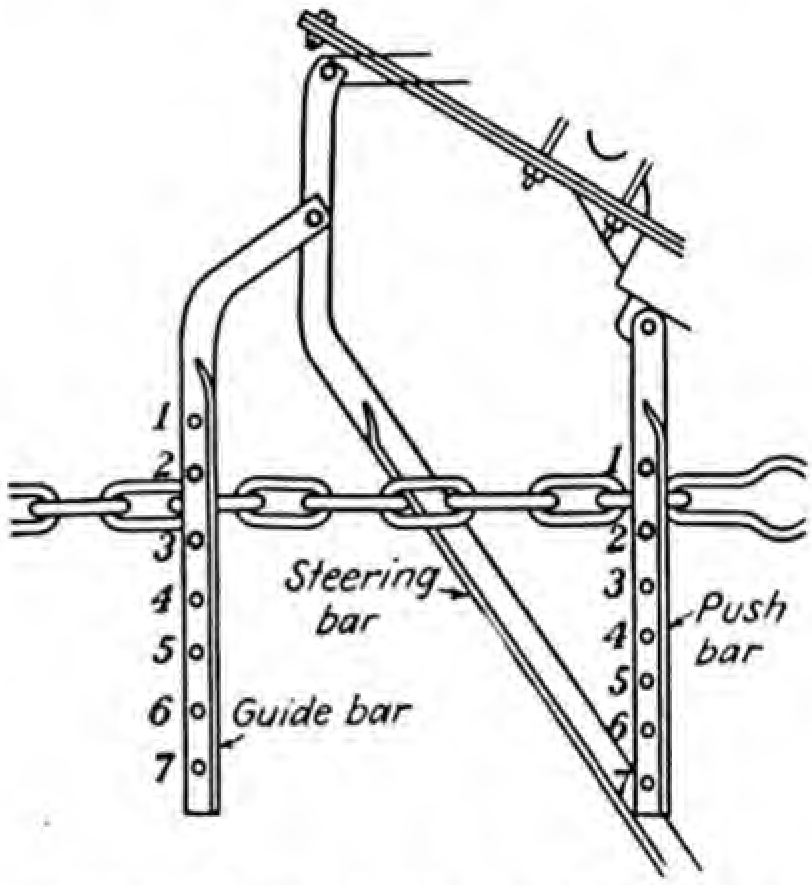


FIG. 180.—Chain and bar hitch for a single-disk plow.

This is particularly true when the plow is tractor-operated. The larger and heavier the tractor, the more damage to the plow. Higher speeds also increase the possibility of damage. Many attempts have been made to make a spring release, tractor declutch, and tractor stop hitch so that automatic recoupling can be accomplished with little loss of time. Such devices are expensive to construct and few are available. Figures 174 and

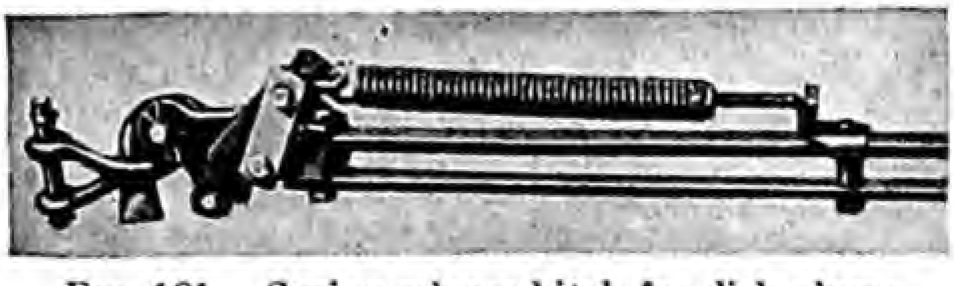


FIG. 181.—Spring-release hitch for disk plows.

181 show simple spring-release hitches for moldboard and disk plows. With each of these hitches it is necessary to recouple the plow. Figure 182 shows a spring cushion to reduce shocks for integral-mounted plows. A. W. Clyde[1] has done considerable research in an attempt to develop a hydraulic tractor stop hitch.

[1] *Agr. Eng.*, Vol. 23, No. 1, p. 5, 1942.

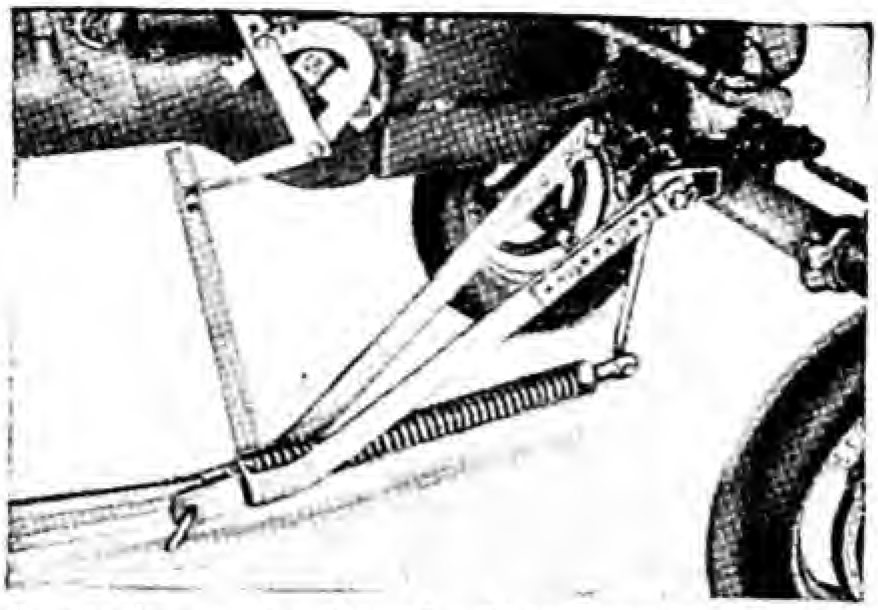


FIG. 182.—Cushion spring reduces shock on both tractor and plow when rocks or roots are hit by integral-mounted plow.

PLOW TROUBLES

The efficiency of any farm machine depends largely upon the elimination of troubles. Each class of plow, moldboard and disk, as well as each type of walking, riding, and horse- and tractor-operated plow, has troubles and adjustments which are common to all. Each one also has troubles and adjustments applicable only to its certain type.

HORSE-DRAWN-PLOW TROUBLES

177. Walking-plow Troubles

Trouble: Running too deep.

Remedy: Press down on handles, reduce suction, lower hitch at clevis, shorten traces, check for sprung beam.

Trouble: Not plowing deep enough.

Remedy: Raise up on handles, increase suction, raise hitch at clevis, lengthen traces, check for sprung beam.

Trouble: Not taking enough land; plowing furrows too narrow.

Remedy: Increase horizontal suction, move hitch to right at clevis, decrease wing bearing, check setting of coulters.

Trouble: Taking too much land; plowing furrows too wide.

Remedy: Decrease horizontal suction, move hitch to left at clevis, increase wing bearing, check setting of coulters.

Trouble: Failing to scour; soil sticks to plow and will not shed clean.

Remedy: See that plow has good polish, adjust plow properly: fitting of share and moldboard must be close, even, and smooth, cutting edge must be level; increase vertical suction, plow when soil conditions are right, choose smooth moldboard with right curvature, select plow shape suitable to soil type, increase speed to increase pressure and scouring, heat bottom.

Trouble: Excessive draft.

Remedy: Check condition of hitch, condition of the share, offset pull, set of plow, type of moldboard, and setting of coulters.

178. Riding-plow Troubles

Trouble: Excessive draft.

Remedy: Sharpen shares, reduce vertical suction, adjust hitch and set of wheels to

reduce landside friction. There should be at least ½-inch "heel" clearance under landside and furrow wall at heel of landside.

Trouble: Failing to scour.

Remedy: Same as for walking plows.

Trouble: Plowing uneven furrows.

Remedy: Level plow, adjust hitch and setting of wheels so that all bottoms will cut same width of land, tighten frame to hold plow rigid. Both furrow wheels should have slight lead away from furrow wall.

Tractor-plow Troubles

Many troubles encountered in tractor plows do not develop in the smaller horse-drawn plows. To adjust the tractor plow properly to the tractor so as to eliminate all troubles is often difficult for the plowman.

179. Tractor Moldboard-plow Troubles.

Trouble: Offset pull or side draft.

Remedy: Adjust hitch as explained under Hitches.

Trouble: Poor penetration.

Remedy: Increase vertical suction by raising rear of plow for trailing plows, and by adjusting lever on integral-mounted plows; sharpen or put on new shares.

Trouble: Breaking the furrow wall.

Remedy: Reduce angle of pull to the left to reduce landside pressure on furrow wall, check setting of coulters.

Trouble: Excessive draft.

Remedy: Reduce angle of pull, sharpen shares, reduce vertical suction, check to see that plow is scouring.

Trouble: Failing to scour.

Remedy: Same as for walking plows. See that both vertical and horizontal line of hitch are correct for trailing plows and that integral-mounted plows are correctly mounted, adjusted, and leveled.

Trouble: Slow to enter ground.

Remedy: Loosen tension on lifting springs, see that snares are sharp and have proper down suction, and raise hitch at clevis.

Trouble: Slow in lifting; power-lift wheel slides.

Remedy: Tighten tension on lifting springs, raise hitch slightly at clevis, or lower drawbar of tractor, put lugs on wheels.

180. Tractor Disk-plow Troubles.—Many troubles encountered in operating disk plows are the same as those for moldboard plows. This is particularly true for the vertical and horizontal lines of hitch. Troubles specifically applicable to disk plows are as follows:

Trouble: Failing to penetrate.

Remedy: Set disk more perpendicular, add weight to wheels, sharpen disks.

Trouble: Cutting narrow furrows.

Remedy: Change angle of disk straighter across furrow, move beam to left on front-furrow-wheel axle, adjust lead of front furrow wheel toward furrow wall. Wheels usually are set to run straight forward, parallel to the line of the furrow. For direct-connected plows move hitch to left on drawbar.

Trouble: Cutting wide furrows.

Remedy: Change horizontal angle so that disk will be more parallel to line of furrow, move beam to right on front-furrow-wheel axle, adjust lead of front wheel away from furrow wall. For direct-connected plows move hitch to right on tractor drawbar.

Trouble: Bottoms trailing.

Remedy: Move hitch to left.

Trouble: Poor scouring.

Remedy: Soil may be too wet. Adjust scraper close to the disk.

Trouble: Poor coverage of trash.

Remedy: Set disk more vertically, adjust scraper to turn furrow slice, attach scraper with curved face.

Trouble: Excessive offset pull.

Remedy: Adjust hitch so that the center of load or resistance of the plow falls as nearly as possible behind and in line with the center of the pull, thereby reducing the angle of pull; check condition of disk bearings, see that disks are sharp and that they are scouring completely.

Trouble: Rear furrow wheel kicks out of furrow.

Remedy: Soil may be too hard and dry for penetration. Add more weight to rear furrow wheel, shorten hitch or move it forward on plow, reduce width of cut, see that disks are sharp.

LAYING OUT FIELDS FOR PLOWING

Before plowing is begun much time can be saved if the field is first staked out in lands of uniform width. Methods that leave dead furrows running down the slope should be avoided, as water may collect in them and cause serious erosion. The method of starting at the sides and plowing around and around to finish in the center of the field will, if practiced year after year, create low areas at the dead furrows.

181. Plowing Level Unterraced Fields.—If the field is comparatively level, it can be advantageously plowed in lands. First, headlands approximately twice the length of the tractor and plow should be staked off on all sides. Mark out the headland by plowing shadow once around the field, as indicated in Fig. 183, leaving the corners round to aid in plowing the headland at the finish. Stake out the lands in uniform widths. A multiple of the width of the capacity of the plow should be used. A good device for measuring lands is the A frame shown in Fig. 184. Plow the first furrows through the middle of the second land, then back on the outside of the first land. Continue this procedure until turning is difficult without making a figure-eight turn, then swing over and open up another land and finish the first land on the return trips (Fig. 183). When all the lands have been plowed, plow the headland by throwing the furrows either toward or away from the outside.

182. Plowing Terraced Fields.—Areas between terraces are irregular in width, and the simplest but least desirable method is to plow the whole area between two terraces as one land. This method leaves a dead furrow

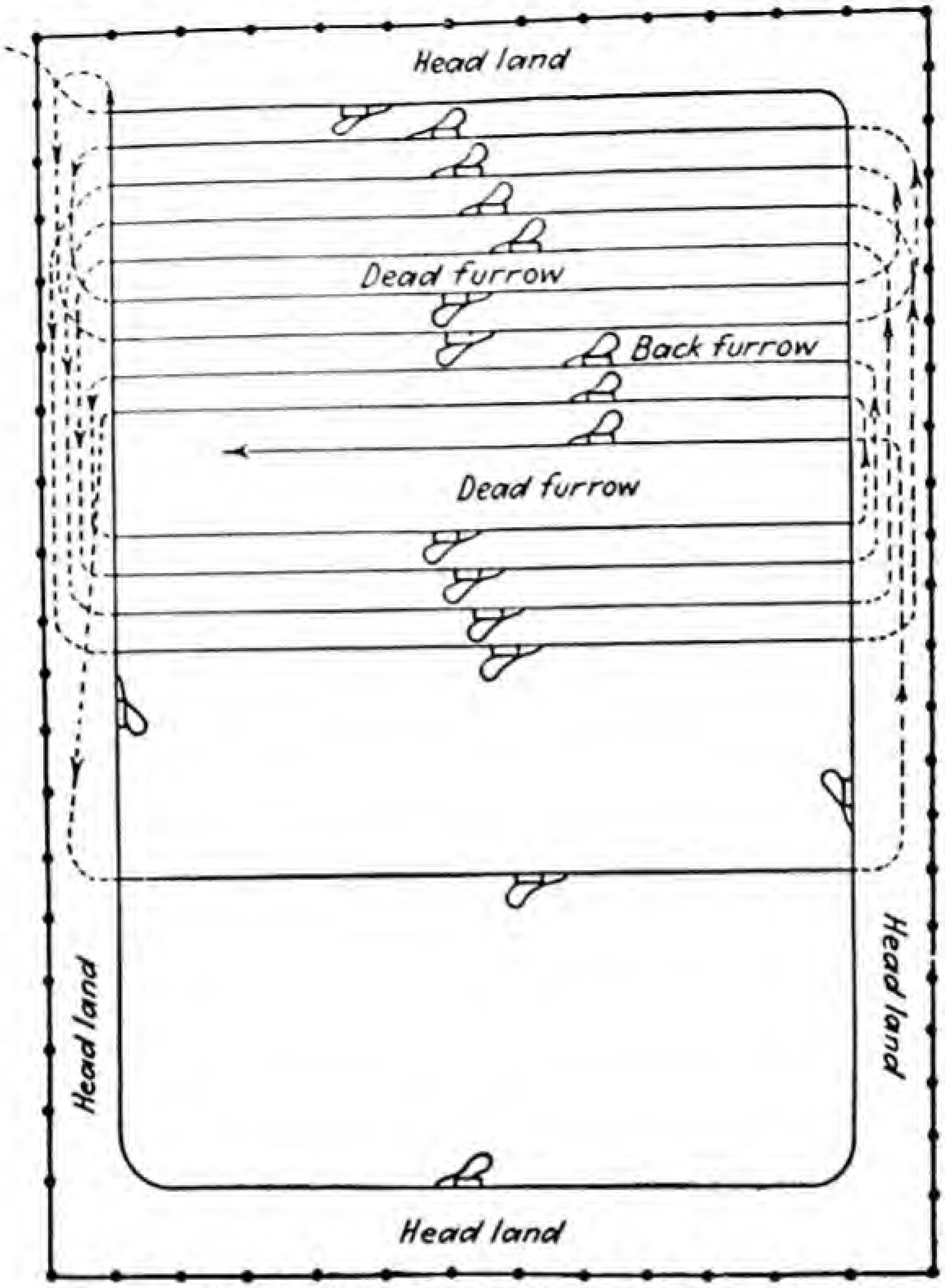


FIG. 183.—Method of laying out field for plowing.

midway between terraces and often results in serious erosion. The most logical way of plowing terraced land is to use a two-way plow. Begin on the downhill side of the terrace, throw all furrows uphill, and continue back and forth until the channel of the next terrace downhill is reached. This method will leave the dead furrow in the channel and aid in clearing it of accumulations of silt. The method also aids in counteracting the downhill movement of the soil.

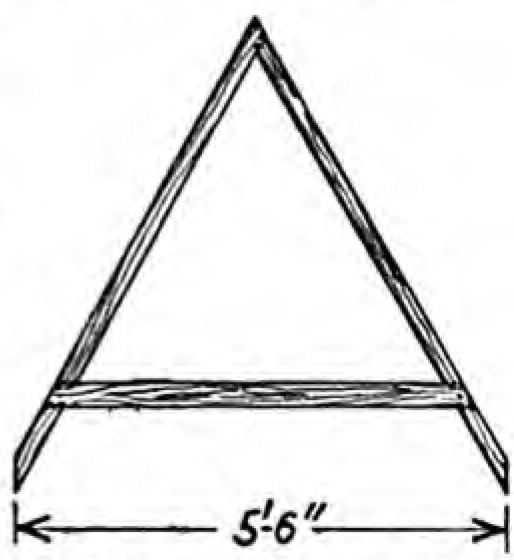


FIG. 184.—An A frame for measuring fields in place of stepping off.

183. Plowing Triangular and Irregular-shaped Fields.—The simplest method of plowing triangular or irregular-shaped fields is to bisect the angles, leaving a strip of equal width on each side of the line unplowed so that all turning can be done on firm soil (Fig. 185). This method will, if practiced, cause the development of deep dead furrows. The use of two-way plows on

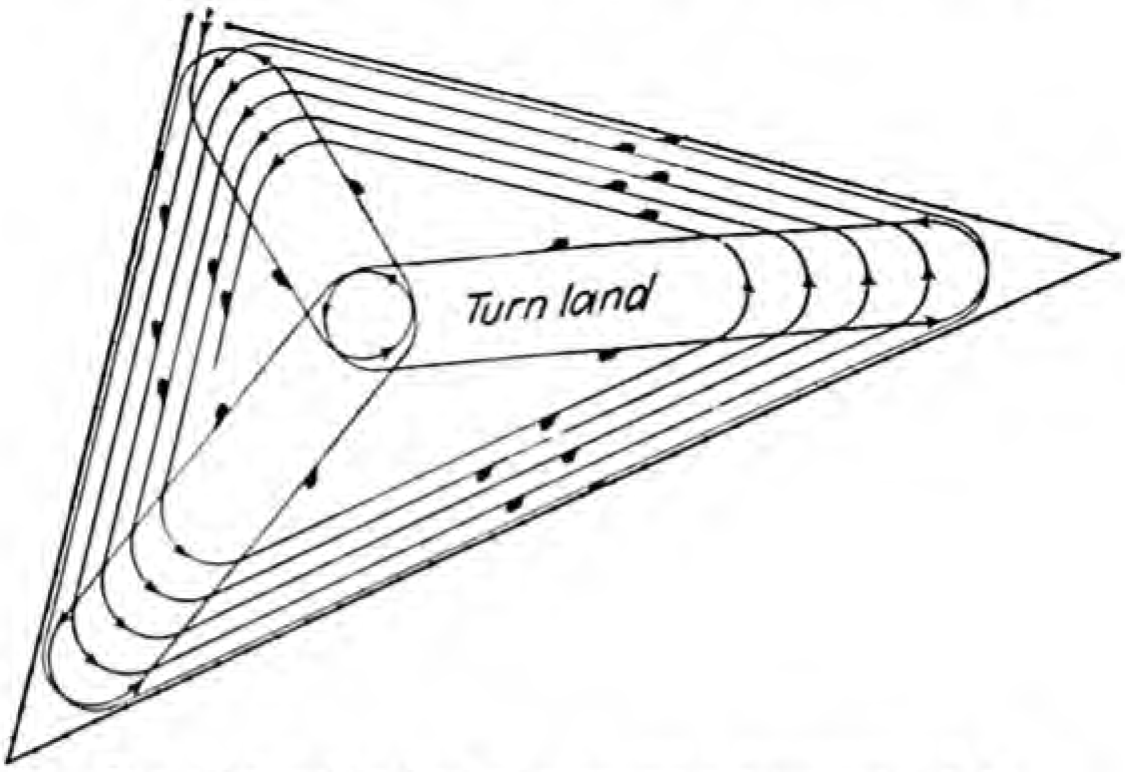


FIG. 185.—Method of plowing a triangular field.

irregular-shaped fields will leave no dead furrows extending inward from the corners.

DUTY, DEPTH, LIFE, CARE AND COST OF PLOWING

184. Duty of Plows.—There is considerable difference in the amount of work that can be accomplished with different types of plows. Table V is a chart from which can be easily and quickly calculated the number of acres that can be plowed with any size plow when traveling from 1 to 10 m.p.h. A plow equipped with two 14-inch bottoms cutting a strip 28 inches wide and being pulled at 3½ m.p.h. will plow 1 acre per hour, or 10 acres in a 10-hour day. A harrow-plow cutting a strip 84 inches (7 feet) wide and pulled at the rate of 4 m.p.h. will cover 3½ acres per hour, or 35 acres in a 10-hour day.

The daily duty of a plow depends on the width of strip plowed, the rate of travel (speed), and the length of time operated.

This can be expressed in the following formula, which allows about 17.5 per cent of the operating time for loss in turning:

$$\text{Acres per 10-hour day} = W \times \text{mph.}$$

where W = width of strip plowed.

mph = miles per hour or rate of travel.

Example: How long will it take to plow a 40-acre field with three 14-inch bottom plows pulled by a tractor at 3 m.p.h.?

Three 14-inch bottoms cut a strip 3½ feet wide.

$W \times \text{mph} = 3\frac{1}{2} \times 3 = 10.5$ acres plowed in a 10-hour day.

$40 \div 10.5 = 3.23$, or a little over 3 days required to plow the 40 acres.

185. Depth of Plowing.—The average depth of fall and spring plowing for the various states is shown in Table VII. The depth a farmer plows will be greatly influenced by the power available, the size of plow, soil

type, rainfall, kind of crop grown, cost, and the benefits measured in increased yields and income.

Hume[1] found that for South Dakota increased depth of plowing up to 8 inches increased the total yields of rotated corn, spring wheat, and legumes.

TABLE VII.—AVERAGE DEPTH OF PLOWING IN THE VARIOUS STATES[1]

State	Fall, inches	Spring, inches	State	Fall, inches	Spring, inches
Maine	7.5	7.6	North Dakota	5.0	4.7
New Hampshire	7.0	6.9	South Dakota	5.1	5.2
Vermont	6.5	6.3	Nebraska	5.2	5.4
Massachusetts	7.4	7.8	Kansas	4.8	5.0
Rhode Island	6.0	6.3	Kentucky	5.9	6.0
Connecticut	6.5	6.4	Tennessee	6.0	5.6
New York	6.4	6.4	Alabama	5.3	4.2
New Jersey	6.4	6.9	Mississippi	4.0	3.3
Pennsylvania	6.7	6.5	Louisiana	5.0	4.3
Delaware	5.9	6.3	Texas	4.9	4.2
Maryland	6.3	6.5	Oklahoma	4.5	4.5
Virginia	6.6	6.5	Arkansas	5.0	4.4
West Virginia	6.1	6.0	Montana	5.5	5.5
North Carolina	6.5	5.8	Wyoming	5.9	5.6
South Carolina	5.8	4.9	Colorado	5.7	6.1
Georgia	5.1	4.0	New Mexico	5.6	5.2
Florida	5.7	4.7	Arizona	5.8	5.8
Ohio	6.4	6.9	Utah	7.5	6.7
Indiana	6.0	6.5	Nevada	6.6	6.7
Illinois	5.7	5.3	Idaho	6.1	6.1
Michigan	6.7	6.4	Washington	6.4	6.4
Wisconsin	6.0	5.7	Oregon	6.0	6.1
Minnesota	5.4	5.0	California	6.1	6.5
Iowa	5.7	5.0			
Missouri	5.6	5.6	United States	5.45	5.12

[1] *U. S. Dept. Agr. Yearbook*, p. 700, 1918.

186. Life of Plows.—Data cited by Davidson[2] show that farmers estimate the life of a tractor plow as 9 years. The number of years of service obtainable from a plow will vary with the number of days used per year, the care given the plow, and how well it is kept in repair. The average number of days a tractor plow was used annually was 16 days. Large farms used the plow more days during the year than small farms.

[1] HUME, A. N., Crop Yields as Related to Depth of Plowing, *S.D. Agr. Expt. Sta. Bull.* 369, p. 3, 1943.

[2] DAVIDSON, J. B., Life Service and Cost of Service of Farm Machinery, *Iowa Eng. Expt. Sta. Bull.* 92, p. 7, 1929.

Musselman[1] states that tractor disks and tractor plows should last from 10 to 15 years.

187. Care of Plows.—Even though plows are rugged pieces of equipment, they require a certain amount of care. A few minutes spent each morning, before starting the day's work, in checking the tightness of all nuts, bolts, and connections will frequently prevent serious accidents and breakdowns. Use a pressure grease gun on all grease fittings each morning and see that all points are well lubricated. All wheel bearings and points where there is much movement should be lubricated again at noon, or after every 5 to 6 hours of operation.

188. Cost of Plowing.—Jensen[2] figures the cost of plowing an acre with a two-horse walking plow as follows: Acres plowed per day, 1.8. Man-hours per acre, 5.55. Man labor cost, \$0.83 per acre. Mule-hours per acre, 11.0. Cost of mule labor per acre, \$1.28. Total cost per acre, \$2.11.

A man-hour was figured to be worth \$0.27 while a horse-hour was worth \$0.17. At this rate, horse plowing cost \$2.63 per acre. When \$0.85 was figured for a tractor-hour, the total cost of plowing an acre was \$1.37. Of course, the unit allowed for man, horse, and tractor hours will vary with the sections and conditions.

TABLE VIII.—COMPARISON OF REQUIREMENTS PER ACRE OF HORSE AND TRACTOR PLOWING[1]

	Hours per acre with man and horse		Hours per acre with man and tractor	
	Man-hours	Horse-hours	Man-hours	Tractor-hours
Plowing..............	2.7	11.2	1.3	1.2

[1] *U. S. Dept. Agr. Bull.* 1198, p. 9, 1924.

In some of the Middle Western states, where four- and five-bottom plows are used, farm-power contractors in 1936 charged from \$1.10 to \$1.25 per acre for plowing under average conditions. For unusually heavy land and small fields the charge ran as high as \$1.77 per acre.

[1] MUSSELMAN, H. H., Efficient Use of Farm Production, *Mich. Agr. Expt. Sta. Cir.* 183, p. 8, 1942.

[2] *S.C. Agr. Expt. Sta. Bull.* 221, p. 26, 1924.

PART IV

SEEDBED-PREPARATION MACHINERY

CHAPTER XV

STALK CUTTERS, HARROWS, SOIL PULVERIZERS, AND SUBSURFACE TILLAGE TOOLS

The action of the plow on the soil does not prepare an ideal seedbed. Unless the soil is very sandy, loose, and mellow, it needs further pulverizing by the use of tools specially prepared for the purpose. These tools are used principally in the preparation of the plowed ground for the seed. Some of them are used before plowing; however, others may be used later to cultivate the growing plants.

STALK CUTTERS

189. Horse-drawn Stalk Cutter.—If the crop grown produces large stalks, such as cotton, sorghum, and corn, it is necessary to cut them into

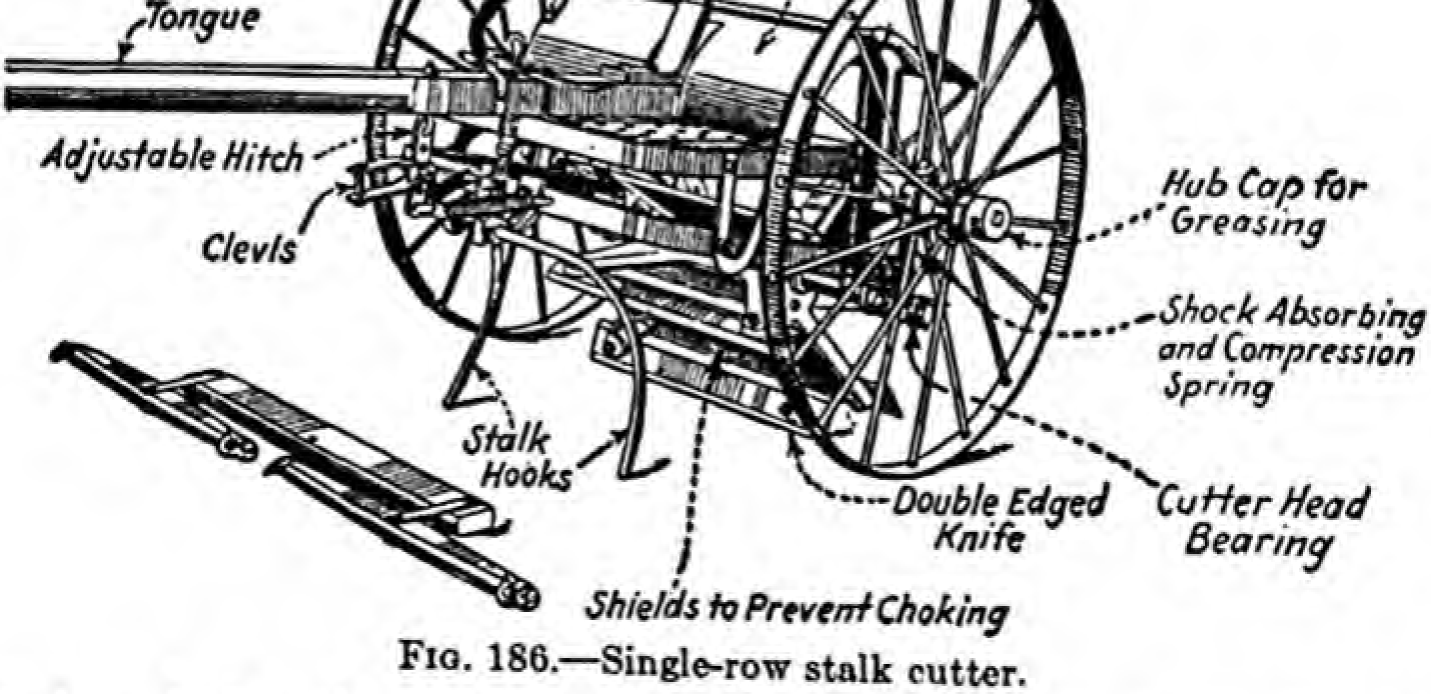


Fig. 186.—Single-row stalk cutter.

short pieces before the ground can be plowed and vegetable matter buried.

Figure 186 shows an ordinary single-row stalk cutter. It is also built in a two-row unit with two cutting heads.

The cutting head consists of two spider castings to which are bolted knives. Both sides of the knives are sharpened so they can be reversed when one side becomes dull. Usually provision is made to prevent the knives shearing the bolts that hold them on. This may be either a shoulder for the knives to rest against or a projection of the casting through the knife at the bolt hole.

Some cutters are built to prevent the cutting head from clogging with stalks. Strips of sheet steel (Fig. 186) extending from the knife to the axle keep the pieces of stalks from collecting in the center of the cutting head. Some farmers clean the cutting head of stalk cutters, not provided with the anticlogging sheets of steel, by burning the collected mass of stalks. This practice, however, is not advocated, as the heat may destroy the temper of the steel cutting knives.

FIG. 187.—Showing how stalk-cutter knives are fastened to spider.

Stalk hooks are necessary to pull the stalks parallel to the row so that the knives can cut them.

When in operation, the entire weight of the machine and operator is placed upon the knives to force them into the soil and cut the stalks. To prevent rigidity and roughness of riding, pressure or shock-absorbing springs are provided (Fig. 186).

Other methods of disposing of stalks are:

1. Drag them down with a heavy weight, such as a railroad rail and run over them with a tandem disk harrow.

2. Use especially constructed, well-sharpened, angle-iron cleats on the rear wheels of a tractor to cut up large cotton stalks satisfactorily.

3. Use a good homemade stalk cutter, made by attaching long knives to a cast-iron or wood drum.[1]

190. Tractor-drawn Stalk Cutter.—A two-row tractor-drawn stalk cutter is shown in Fig. 188. The four knives are made of tough steel and

[1] *Tex. Agr. Expt. Sta. Bull.* 362, p. 9, 1927.

are bolted to four forged-steel spiders. The cutting width of a single head is 76 inches. Special hitches can be secured for a four- and six-row hookup. The bar on top and in the center of the frame provides a means of hitching a harrow behind the cutter.

For transporting, the machine is ended over on the transport skids. Many farmers make homemade tractor-drawn stalk cutters.

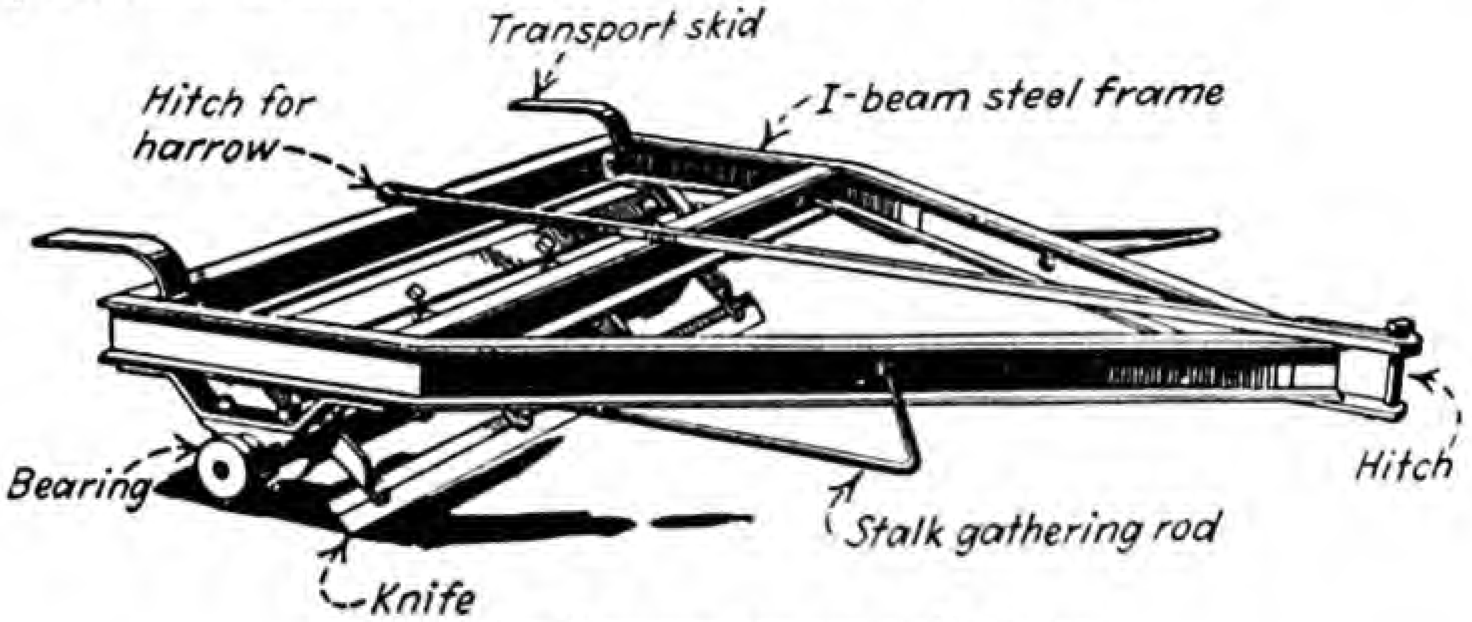


FIG. 188.—Two-row tractor stalk cutter.

191. Pasture Stalk Cutter for Weeds and Sprouts.—The principal difference between the regular tractor stalk cutter previously described and the pasture cutter is that the latter has a larger wheel and more knives (Fig. 778). The knives are spaced 7 inches apart on large spiders. The wheel or cutter head is 24 inches in diameter. The frame is built of heavy I-beam structural steel.

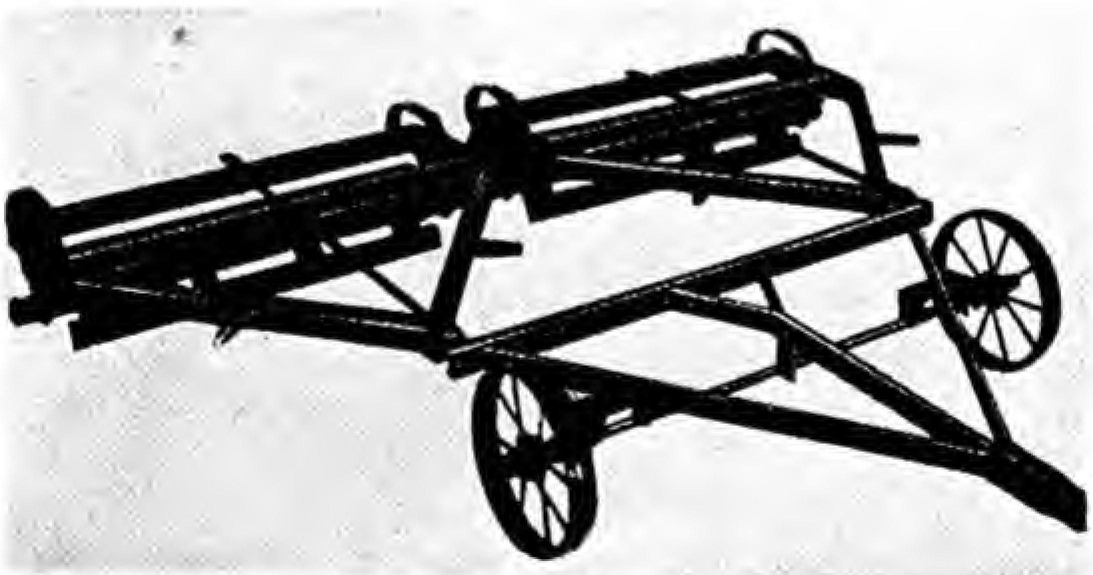


FIG. 189.—Special "squadron" hitch for hitching two two-row tractor stalk cutters together, making a four-row unit.

When this cutter is pulled at 3 to 4 m.p.h. or faster, the closely spaced knives chop down and cut up thick growths of weeds and young sprouts. The knives cut lightly into the turf, giving light cultivation.

HARROWS

The harrow is an implement used to level the ground and crush the clods, to stir the soil, to prevent and eradicate weeds, and to cover seed.

There are four principal kinds of harrows, namely, the spike-tooth, the spring-tooth, the disk, and the acme.

192. Spike-tooth Harrows.—Spike-tooth harrows, as shown in Fig. 190, are so called because the teeth resemble long spikes. This harrow

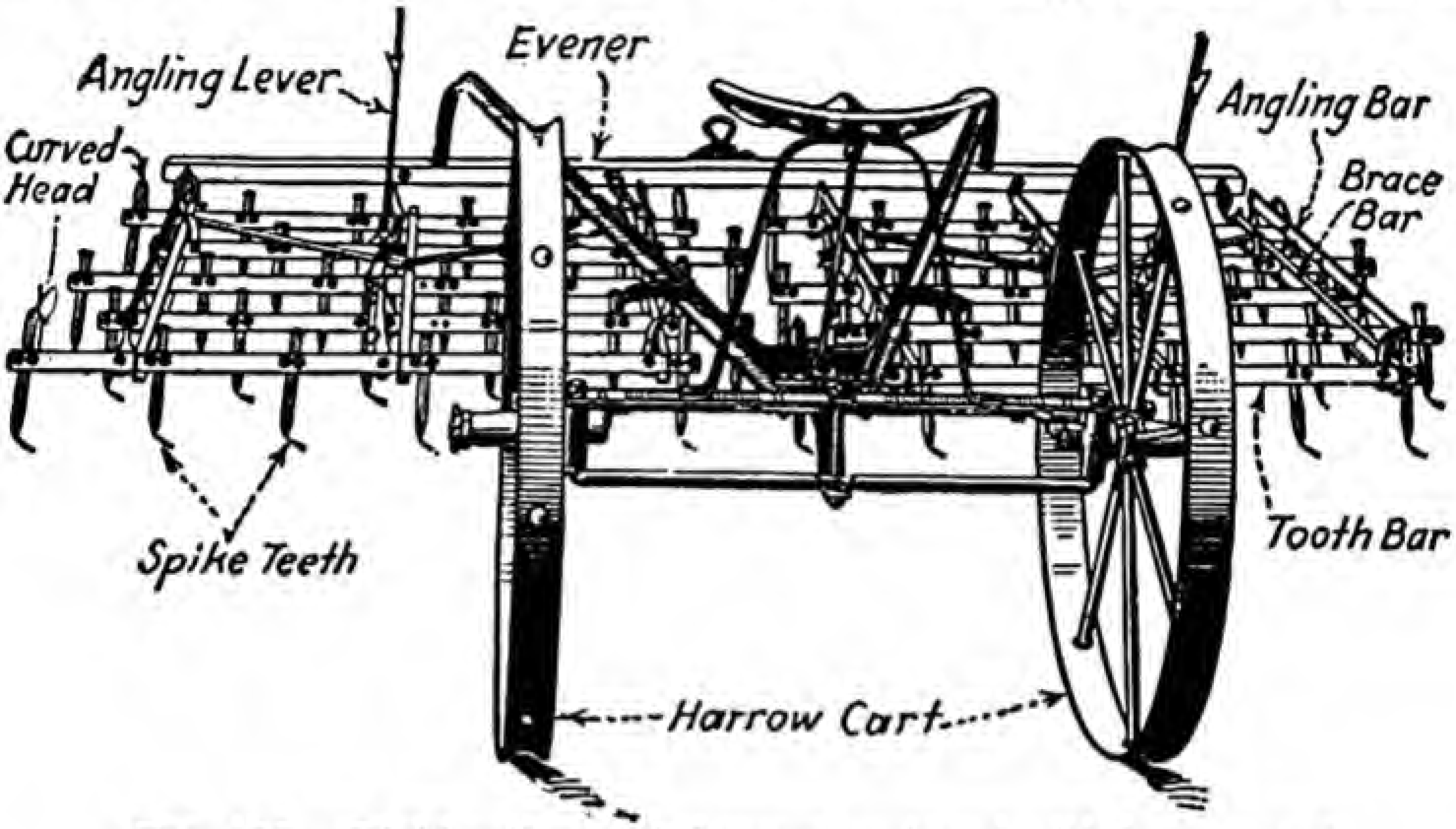


FIG. 190.—Rigid spike-tooth harrow equipped with harrow cart.

is also known as a *peg-tooth harrow*, a *drag harrow*, a *section harrow*, or a *smoothing* harrow. The principal use of the spike-tooth harrow is to smooth and level up the soil directly after plowing. It will stir the soil to a depth of about 2 inches if weighted, but, as a general rule, it is not considered a very good clod crusher unless the soil is rather mellow. This type of harrow is used in the cultivation of corn and cotton and other crops for the first time; it saves much time and labor. Spike-tooth harrows are made in sections. Each section may be 4 to 5 feet wide and have 25, 30, or 35 teeth. Several sections can be used together, depending on the power available.

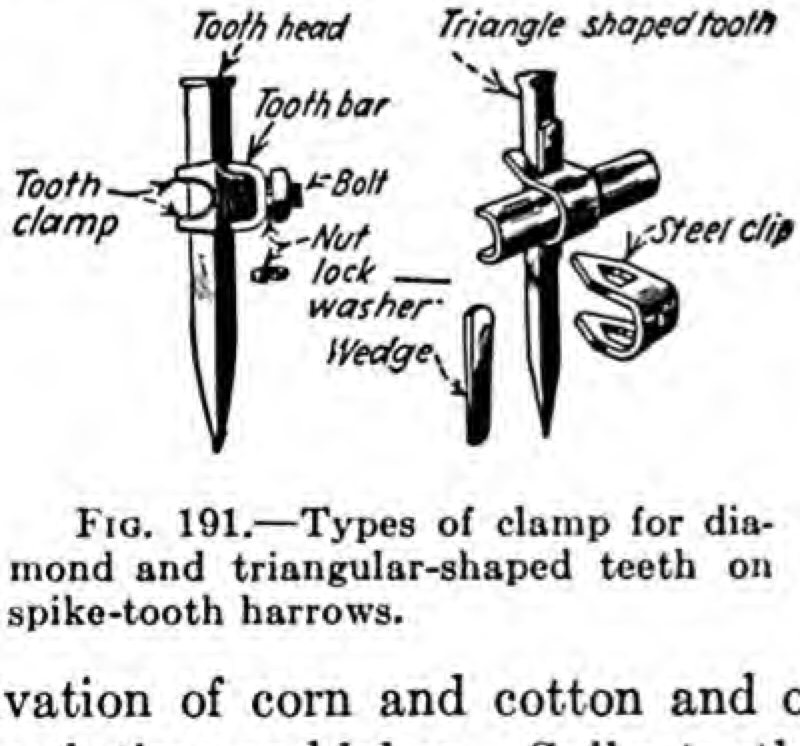


FIG. 191.—Types of clamp for diamond and triangular-shaped teeth on spike-tooth harrows.

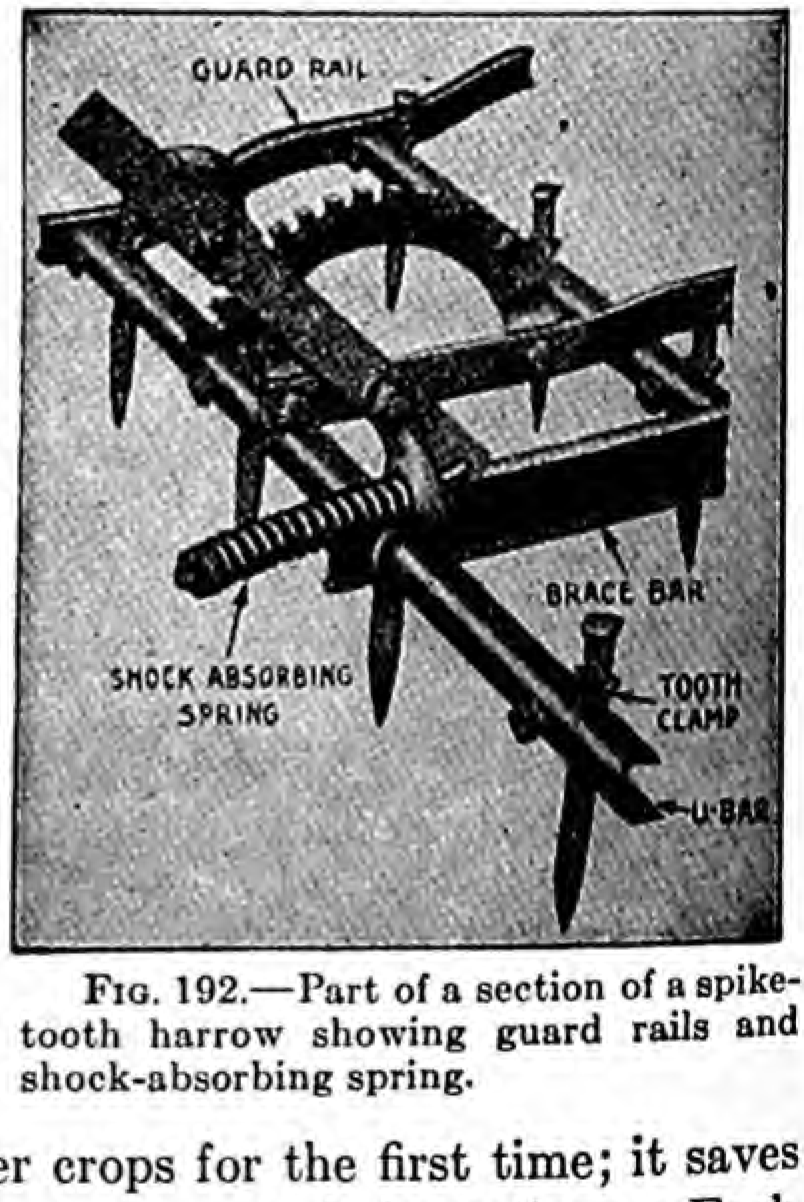


FIG. 192.—Part of a section of a spike-tooth harrow showing guard rails and shock-absorbing spring.

The harrow is made up of a number of teeth attached to bars, which may be of steel or wood. If made of steel, they are usually U-shaped steel bars. The teeth are then placed across the face of this U and held firmly against the edges by means of clamps, which may take a number of forms, two of which are shown in Fig. 191. The ends of these bars are often protected by a guard rail (Fig. 192) which is a strap of steel placed along the end of the bars to prevent them from hanging on any obstruction, such as stumps, gates, and fences. When guard rails are used, the harrow is called a *closed-end* type. Harrows without guard rails are *open-end* types.

The teeth may be made in several different shapes, such as round, oval square, triangular, or diamond. The diamond-shaped tooth (Fig. 191) seems to be the most popular, because of the fact that it may be reversed and present a new cutting edge when one side of the tooth has become dull. The sharp corner of the tooth also aids in holding it firmly against the bar. All teeth should be provided with heads to prevent losing them if the clamps become loose.

At each corner of the section there is a tooth with a head that is long and curved in such a manner that, when the teeth are placed flat, these teeth will serve as runners (Fig. 190). The points of the teeth during transportation from one field to another are not dragged over the roads and worn.

The teeth should have a wide range of adjustment varying from a horizontal to a vertical position. Any angle desired can be had by means of levers provided for the purpose.

193. Rigid and Flexible Harrows.—Spike-tooth harrows are made either rigid or flexible. They are rigid when the steel bars have a brace

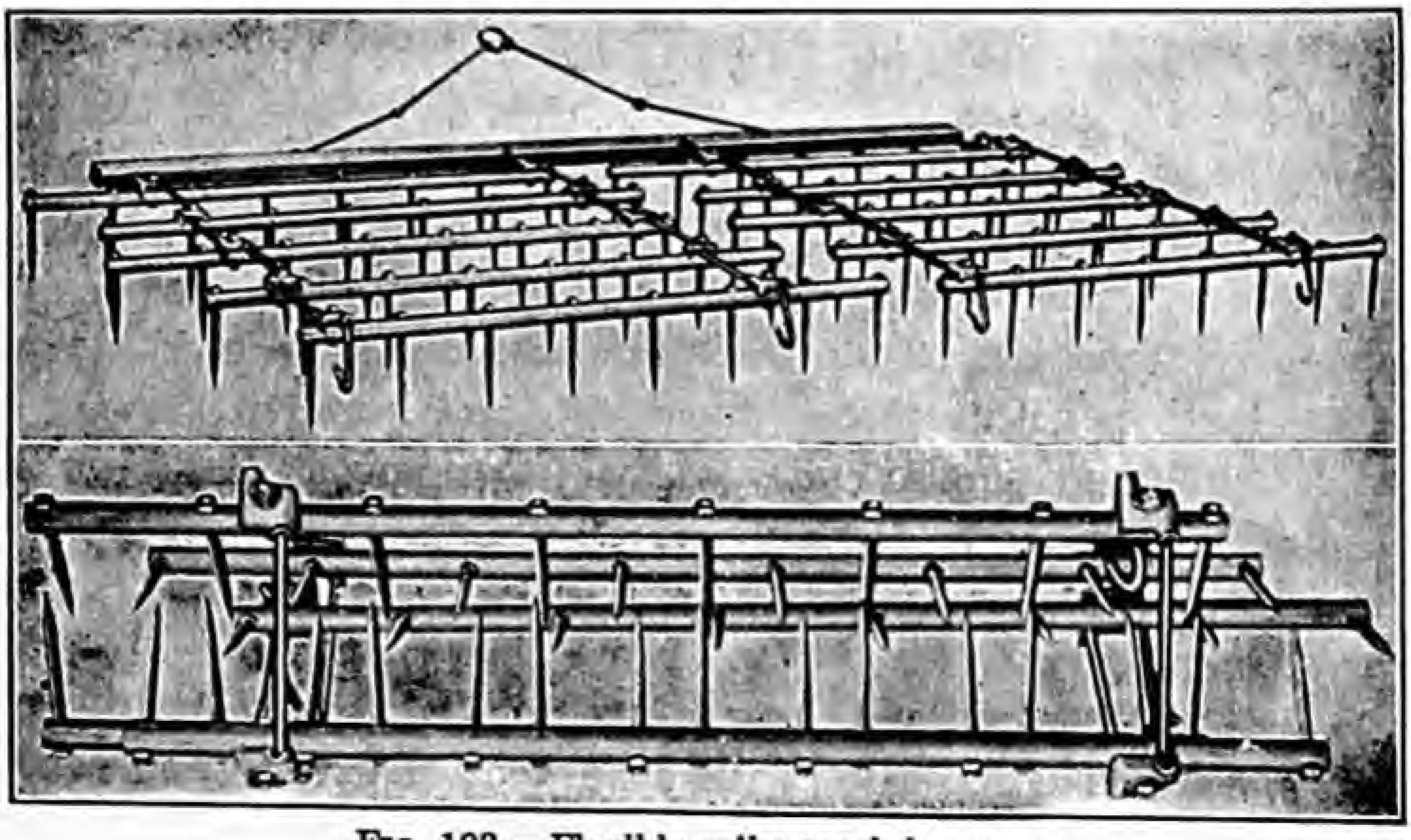


Fig. 193.—Flexible spike-tooth harrow.

across them at right angles to the teeth bars, as shown in Fig. 190. There is no means of adjustment other than that of adjusting the angle of the teeth. A flexible harrow (Fig. 193) may be rolled up, as the links between each tooth bar are hinged. This also allows the harrow to adjust itself to uneven ground much better. Such harrows are provided with draft hooks on both sides. The angle of the teeth cannot be changed.

194. Riding Attachments.—A special attachment called a *harrow cart*, shown in Fig. 190, can be secured to fit any spike-tooth harrow. A harrow cart consists of two wheels, axle, and seat, which is connected to the evener in front of the sections by long bars. If the harrow cart is not used, the operator may ride by standing on a board placed across two sections.

195. Horse-drawn Spring-tooth Harrow.—The spring-tooth harrow, as shown in Fig. 194, is made up on somewhat the same general plan as

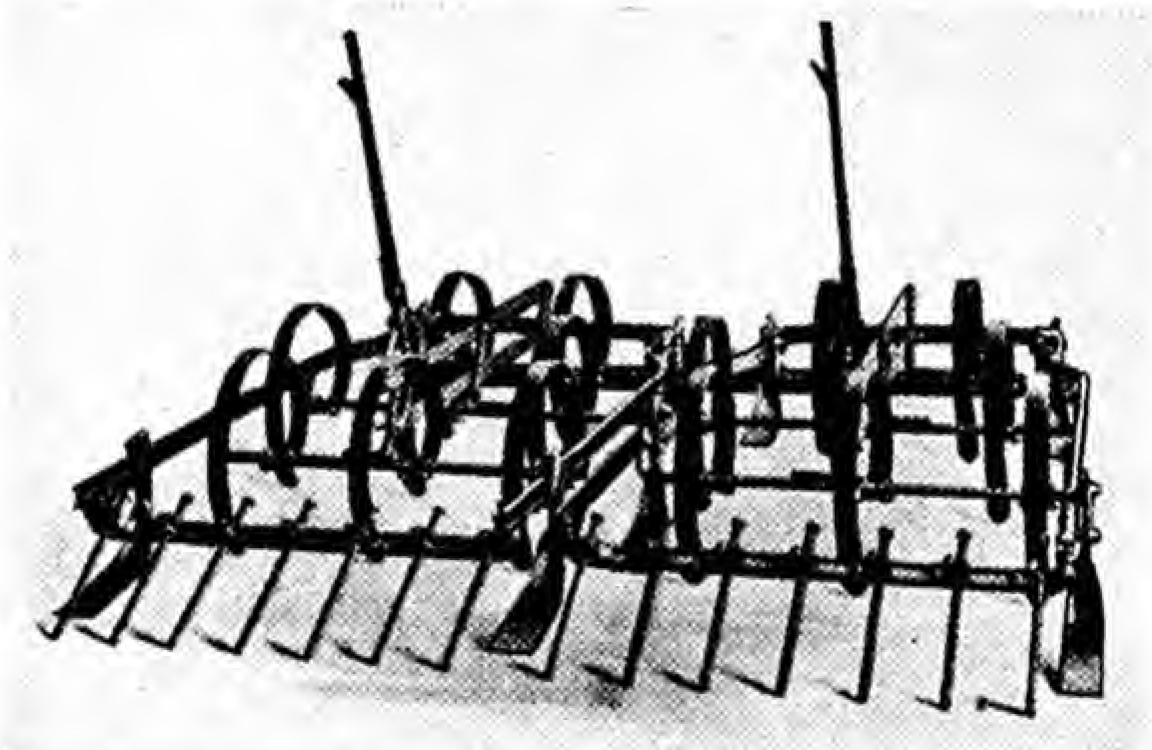


FIG. 194.—Combination spring and spike-tooth harrow equipped with gage shoes.

the spike-tooth harrow. Spring-tooth harrows are adapted for use in rough and stony ground. They are also used extensively to loosen previously plowed soil ahead of a grain drill seeding rice or small grains. The teeth will penetrate deeper than those on spike-tooth harrows, and they will give when obstructions are struck. The spring-tooth harrow is frequently advertised as a quack-grass and Bermuda-grass eradicator since the teeth penetrate deeply, tear out, and bring the roots to the surface. Alfalfa sod is also cultivated with spring-tooth harrows. The teeth consist of wide, flat, curved, oil-tempered bars of spring steel, one end of which is fastened rigidly to a bar; the other end is pointed to give good penetration (Fig. 197). The depth to which the teeth will penetrate the soil is controlled by adjusting the angle of the teeth by means of levers as in the case of the spike-tooth harrow. Some spring-tooth harrows are provided with a power-angling hitch. The tractor is

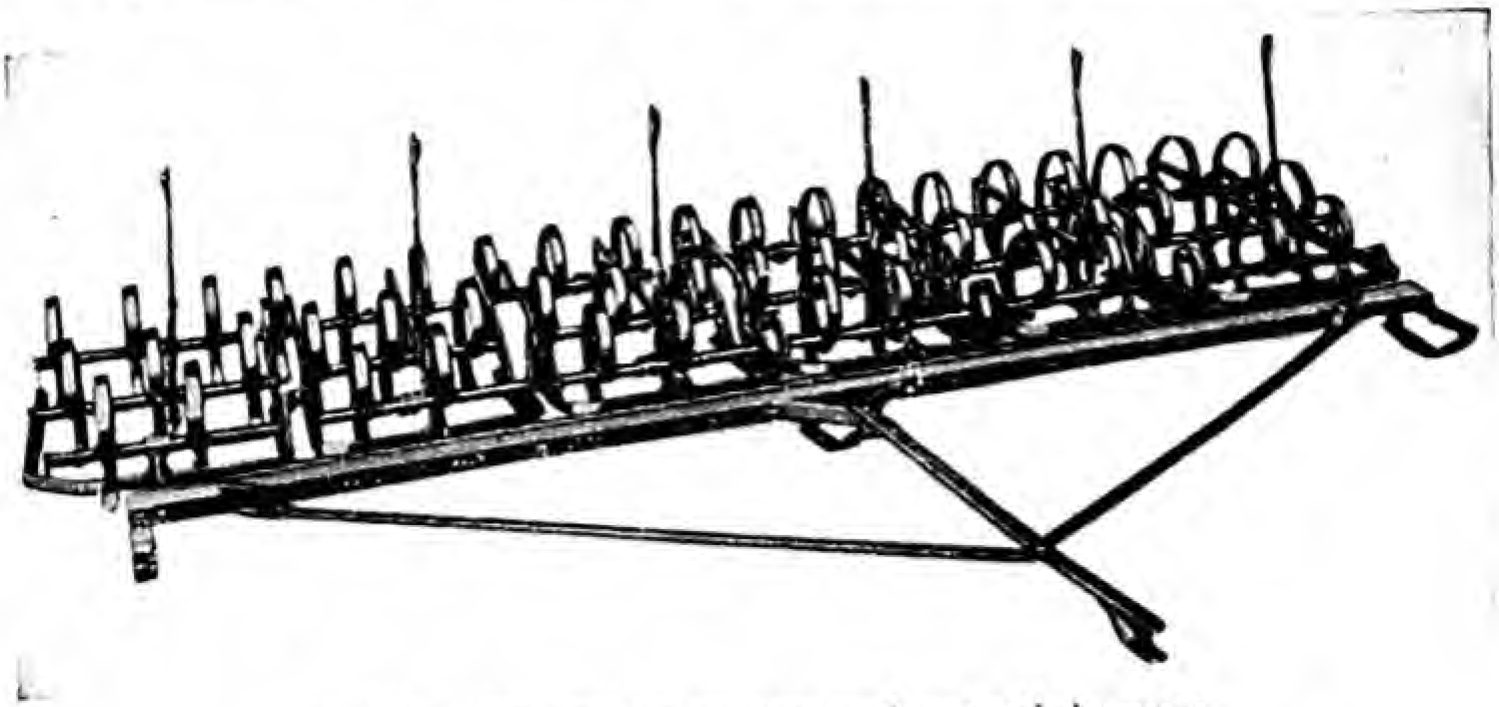


FIG. 195.—Six-section tractor spring-tooth harrow.

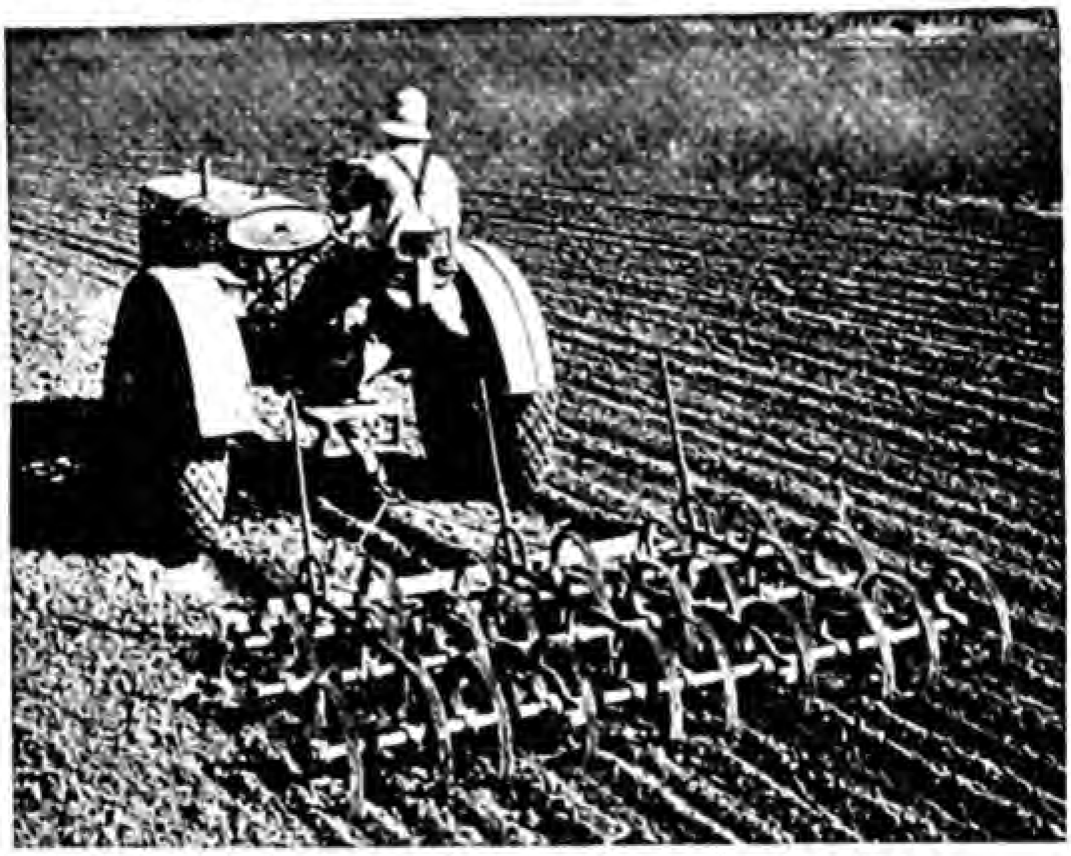


FIG. 196.—Spring-tooth harrow drawn by tractor.

backed to place the teeth in working position and for the desired depth. This is also supplemented by the weight of the harrow. Wheels or runners are provided as a means for transportation.

Figure 195 shows a six-section tractor-drawn spring-toothed harrow equipped with tractor hitch.

196. Special Harrow Teeth.—Some spring-tooth harrows are made with teeth having detachable points (Fig. 197). Points of various widths can be obtained according to the purpose and type of work to be done. For harrowing recently broken ground, the wide tooth is better. The narrow, sharp point is the best to use for cultivating alfalfa. The narrow point will penetrate deeply into the soil, slipping

FIG. 197.—Types of teeth used on spring-tooth harrows: *A*, regular; *B*, quack grass; *C*, alfalfa, *D*, detachable point.

around the crowns of the roots and not cutting them off as would the wide point.

197. Special Orchard Harrows.—The spring-tooth harrow shown in Fig. 198 is adaptable principally for use with tractors. Such machines have proved valuable in the preparation of seedbeds, stubble land,

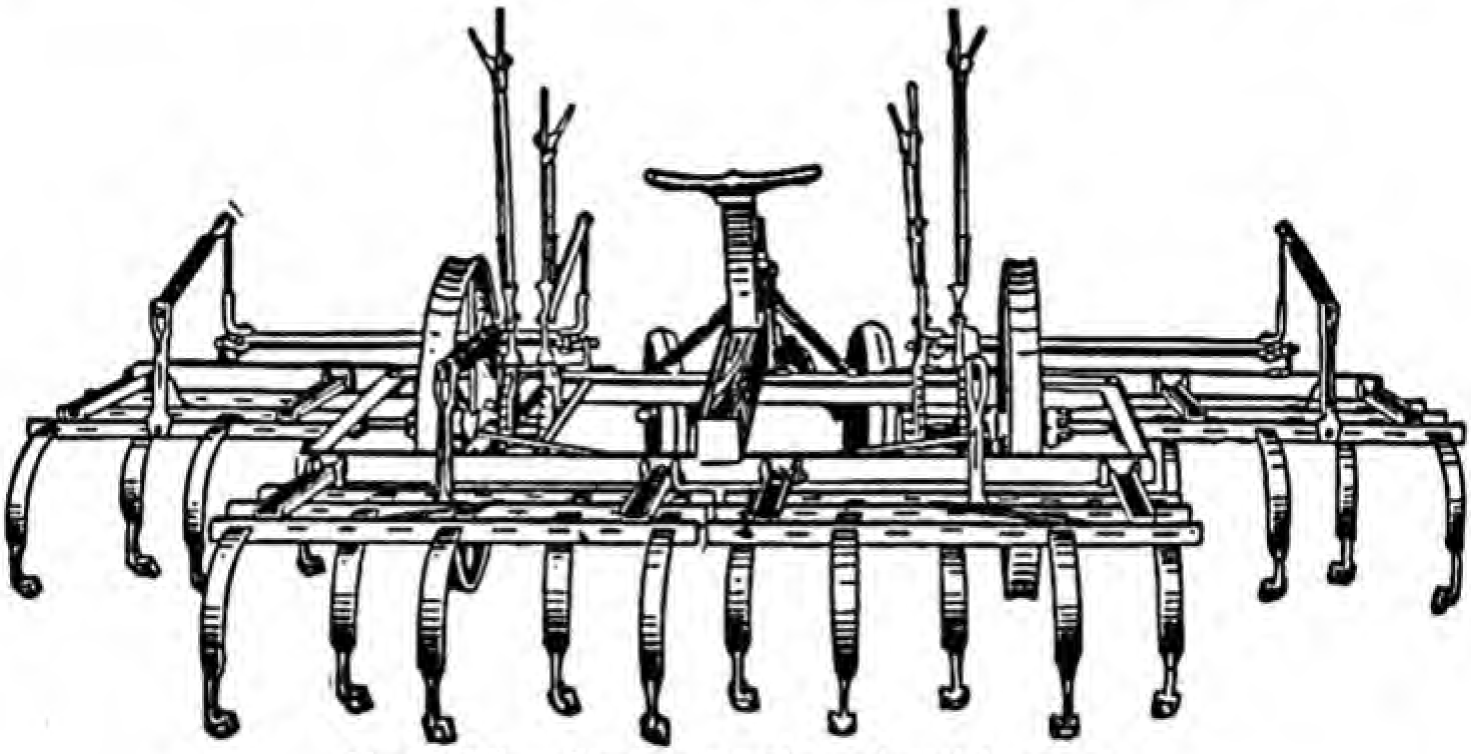


FIG. 198.—Spring-tooth orchard harrow.

summer fallowing, and for destroying thistles. They have become quite popular in the Northwest. This tool is designed in independent sections which are under spring tension, lever controlled, making it possible to regulate uniformly the depth of penetration in the soil. Each section is equipped with heavy, tempered, spring-steel teeth, which have a high throat for clearing heavy trash. It is made of heavy material throughout

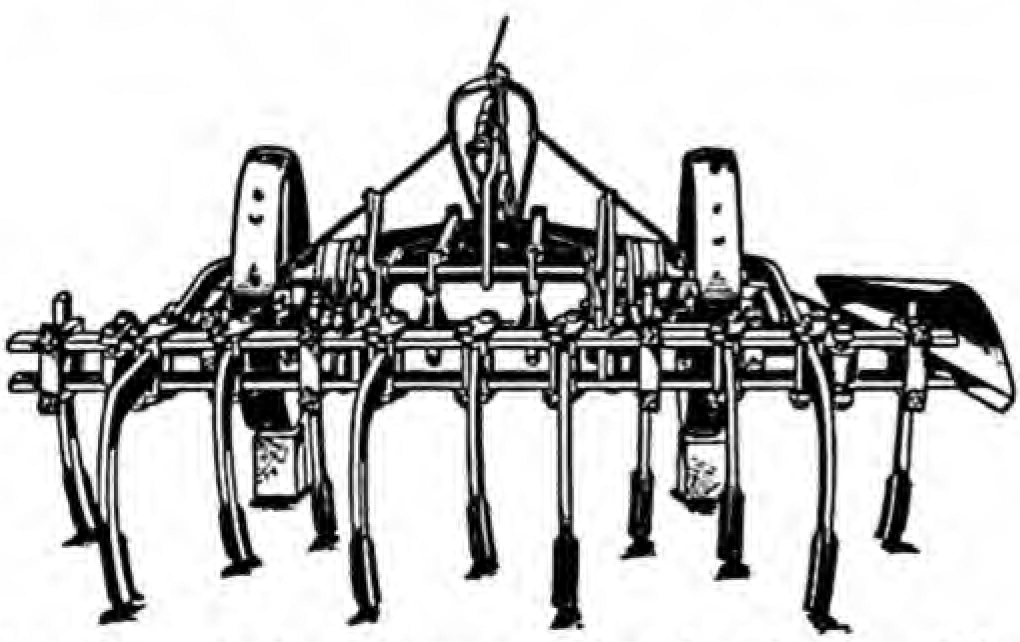


FIG. 199.—Orchard harrow equipped with power lift.

Figure 199 shows a rigid-tooth type of orchard harrow; the main frame is made of heavy angle steel well braced. The harrow is carried on wide steel or rubber-tired wheels. This type of harrow is adaptable for use in extremely hard soils, for subsoiling, and in the preparation of seedbeds.

198. The Acme Harrow.—This type of harrow is sometimes called a *knife harrow,* since the cutting blades consist of large knives. These knives may be either straight or curved. The acme harrow consists of a series of knives attached securely to a frame. The straight knives are so called because the cutting edge is straight, giving a slicing action. The curved knife (Fig. 200) is given a couple of curves and has a tendency to turn the soil more than once. It makes an excellent clod crusher and a good soil mulch. It is also good for orchards and sod land which have recently been plowed. It is very effective in leveling the soil. The harrow is constructed in sizes suitable for one or four horses and for tractors. On the larger types provision is made for the operator to ride. The weight of the harrow may be supported by the knives or the front part of the harrow may be supported by a truck.

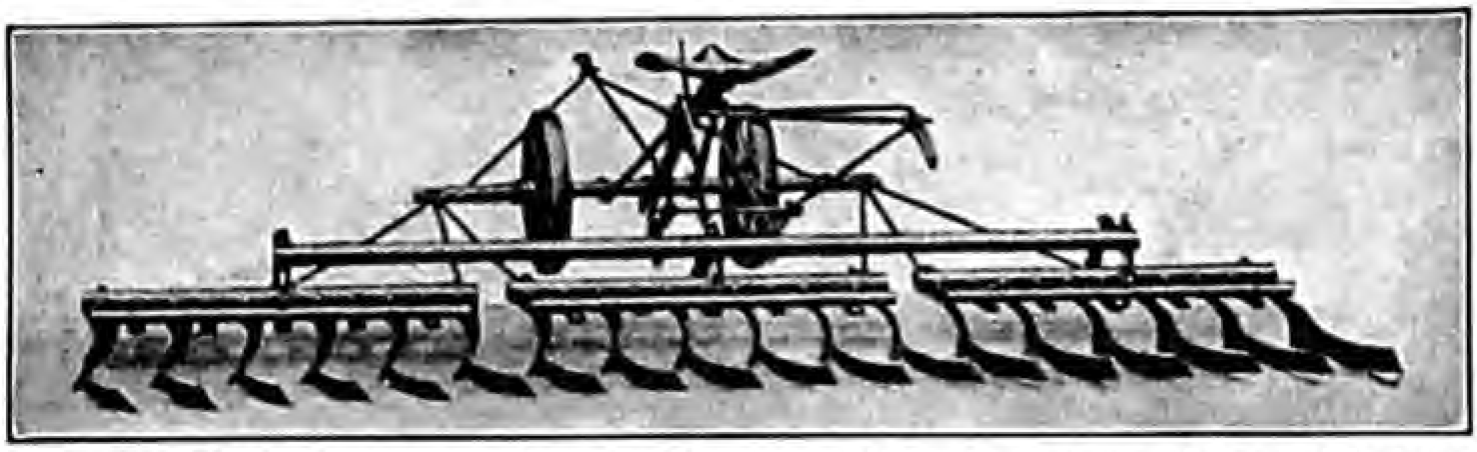


Fig. 200.—Acme harrow equipped with cart and three sections of curved knives.

199. The Disk Harrow.—Next to the plow, the disk harrow is the most valuable tool employed on the farm to prepare the seedbed.

The many uses of the disk harrow are enumerated as follows:

1. It is used before plowing to cut up vegetable matter that may be on the surface, such as cornstalks, cotton stalks, and weeds, and to pulverize the top of the soil to such an extent that the furrow slices will make better connection with the bottom of the furrow soles, preventing air spaces when slices are turned.
2. It is used after plowing to pulverize the soil and put it in better tilth for the reception of the seed. Oftentime land plowed in the fall will need disking in the spring. This will save replowing and put the soil in the best possible condition for spring seeding.
3. It puts all plowed ground in condition for spring planting.
4. It is used for the cultivation of crops.
5. It is used for summer fallowing.
6. When seed are sown broadcast, it is used to cover them.

There are many different types of disk harrows designed to suit different conditions, but they may all be divided into two classes, single and double action.

200. Single-action Disk Harrows.—Single-action disk harrows consist of two gangs placed opposite each other, each gang being set to throw the soil in the opposite direction from the other (Fig. 201).

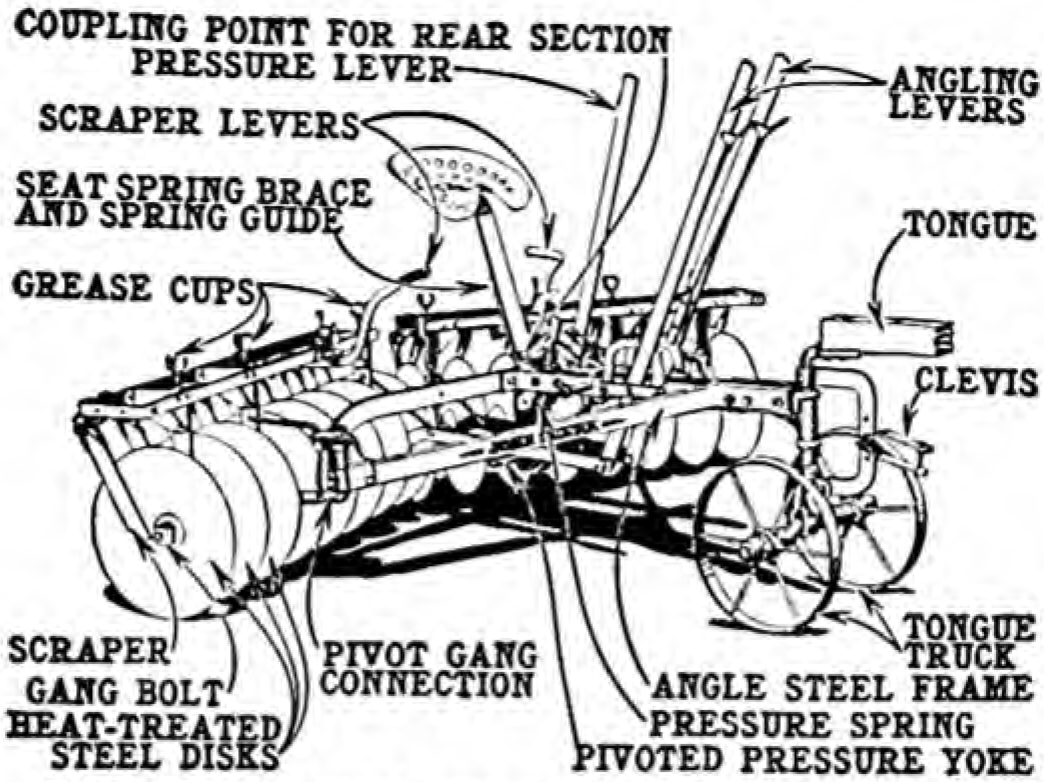


Fig. 201.—Horse-drawn single-action disk harrow.

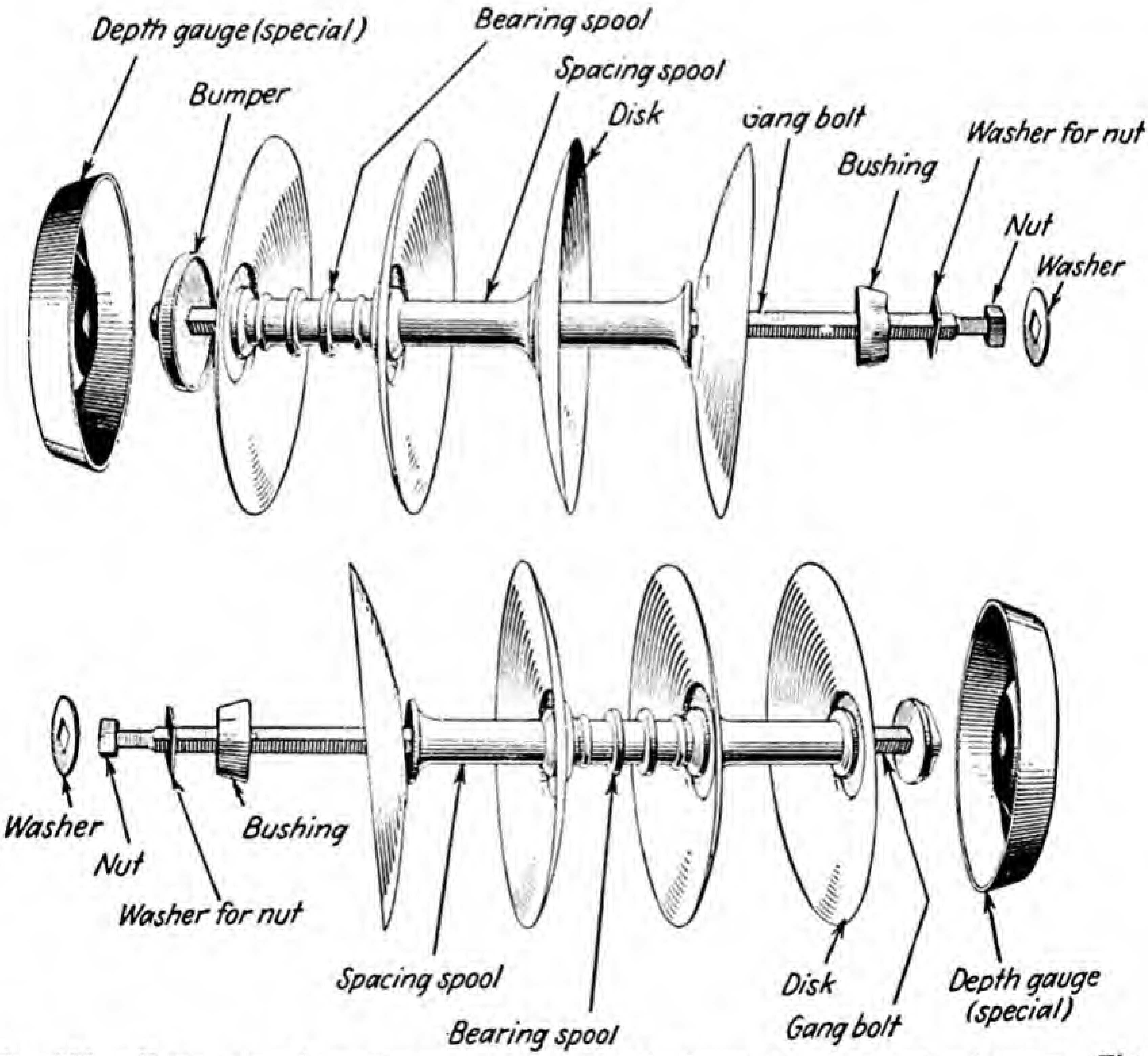


Fig. 202.—Upper gang shows the various parts for the front gang of a tandem harrow. The lower gang show the parts for the rear gang.

201. Disks.—Round, smooth-edged, heat-treated disks are used on all standard disk harrows. A few special harrows are equipped with either *cutaway* or *spading* disks. Disk blades for harrows range from 14 to 22 inches in diameter. The 16- to 20-inch sizes are popular for horse-drawn harrows, and the 18- to 22-inch sizes are common on tractor harrows. Some heavy-duty disk harrows are being equipped with disks 24 and 26 inches in diameter.

Disks for harrows are made of high-grade steel and are heat-treated. The hard heat-treated disks do not crimp up and do not require frequent sharpening.

202. Disk Gangs.—Disk gangs consist of a number of disks spaced about 6 inches apart on a *gang bolt* or *arbor bolt* which holds all the disks rigidly together (Fig. 201). The number of disks on a gang may vary anywhere from three to ten. The disks are held an equal distance apart by a *spool* (Fig. 202). The gang bolt is a square bolt which makes all the disks turn together as a unit. This bolt has a head on one end and a nut on the other. The nut should have some means of locking so that it will not turn off and be lost. If the disks become loose, they will wobble, and poor work will be the result.

203. The Harrow Frame.—The frame of disk harrows is made strong by the use of angle steel. It is well braced and absolutely rigid. Rigidity is necessary so that a certain amount of the end thrust can be taken care of in the frame. The frame is attached to the gang by means of the *standard*, which extends from the frame downward to the bearing on the gang bolt.

204. Bearings.—There may be two to three bearings on each individual gang. These bearings consist of a specially designed spool around

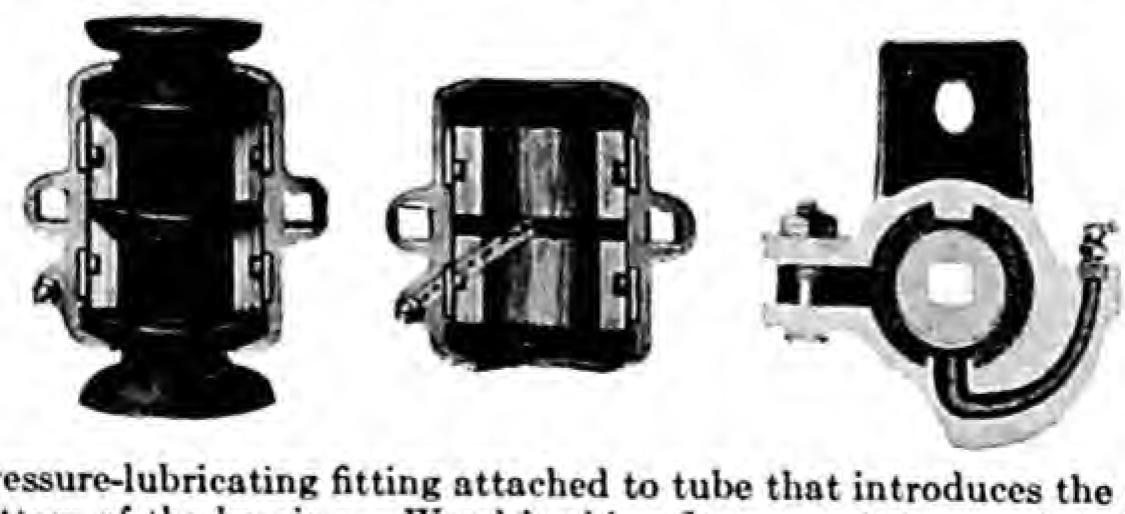


FIG. 203.—Pressure-lubricating fitting attached to tube that introduces the grease into the bottom of the bearing. Wood bushing fits around the spool.

which is bolted a malleable-iron casting which provides a place to attach the standard, also a place for attaching the frame and for angling the gang (Fig. 203). In between the malleable-iron casting and the spool is placed a *bushing* made of wood or chilled iron (Figs. 203 and 204). The wood bushing has been hardened by boiling in oil. It is used for

this bearing because of the large amounts of dust and grit that come in contact with it, in spite of the efforts of the manufacturers to make this bearing dustproof. It is surprising how well these wooden bearings will last. When worn, they can be replaced with only a few cents' cost. Some of the large tractor-drawn double harrows, and one or two single harrows, have chilled-iron bearings eliminating the wooden bushing (Fig. 204). Figure 205 shows a disk harrow gang equipped with roller bearings.

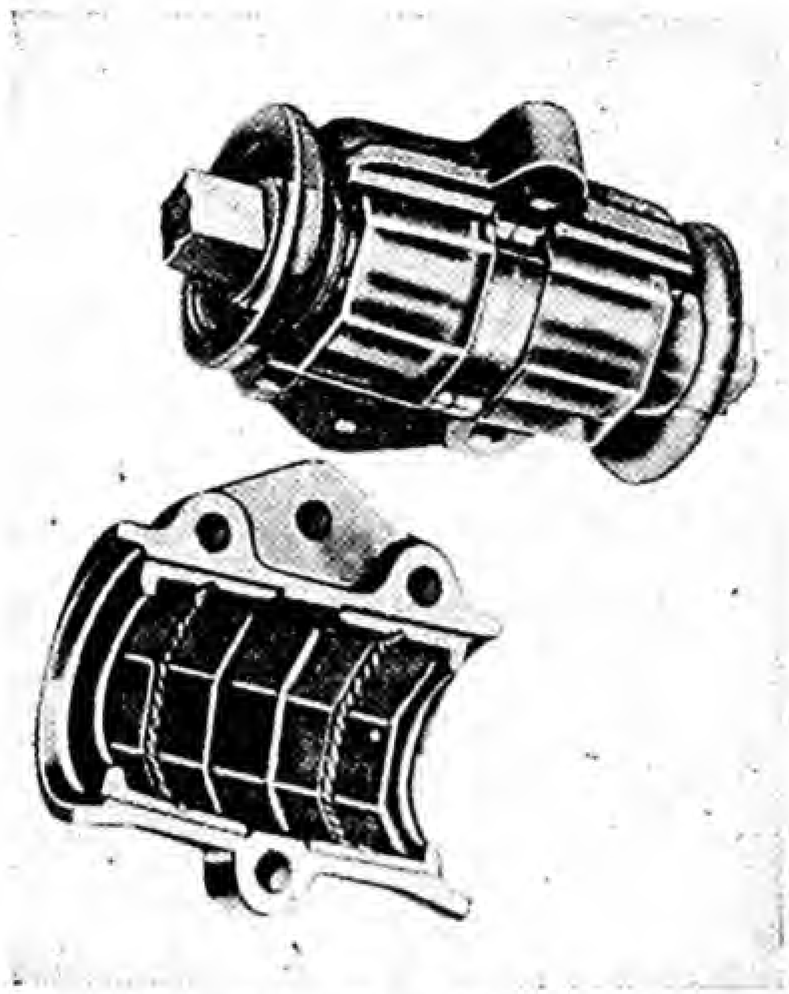


FIG. 204.—An adjustable chilled metal bearing for disk harrows.

205. Lubrication.—Harrow bearings are lubricated by means of grease cups and pressure fittings. Most harrows are lubricated by having holes in the top of the bearing cap into which the pressure fitting is screwed and through which grease is forced into the bearing. The construction of the disk harrow throws the weight of the frame upon the top of the bearing, tending to close the outlet of the grease tube and

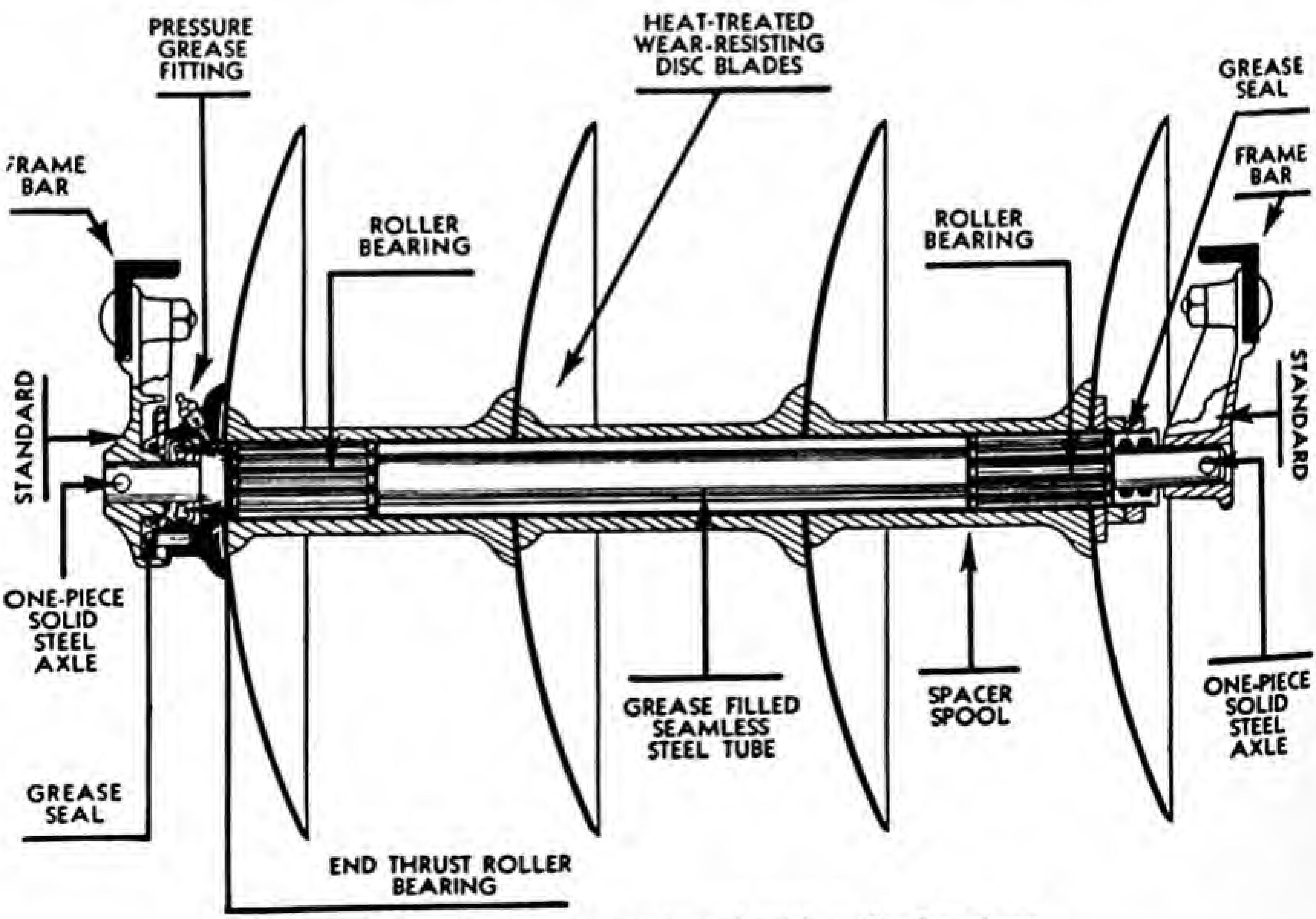


FIG. 205.—Disk gang equipped with roller bearings.

making it very difficult to force the grease into the bearings. Manufacturers have made a decided step forward in the lubrication of harrow bearings. The pressure fitting is screwed directly into the bearing, and the grease is forced through a hollow part of the bearing to the bottom side where it can enter freely between the bearing cap and the spool.

206. Bumpers.—In operation the gangs of disk harrows are set at an angle, which causes a decided pressure to the center. All this cannot be taken care of by the bearings. Bumpers are placed on the inner ends of the gangs, which are allowed to come in contact with each other or bump together. The bumper is a large cast-iron casting placed on the outside of the last disk to take care of the wear which will result when the gangs bump together.

207. Scrapers.—Scrapers (Fig. 201) are placed on the disk harrow to clean the disks. They may be of two types, stationary and oscillating. If stationary, they are bolted rigidly and can be adjusted only a slight amount by means of slotted holes. The oscillating type is held against the disk by springs. Extending out to the front is a foot lever which is attached to the scraper bolt. A downward pressure on the lever will move the scraper from the center of the disk out to the edge, thus cleaning the whole disk as it revolves.

208. Weight Boxes.—Weight boxes or pans (Fig. 206) are provided on disk harrows so that additional weight can be placed on the harrow if penetration cannot be secured otherwise. These boxes may consist of a solid pan or a skeleton-like box. Ordinarily, the weight pans are placed on the frame directly above the gangs. They provide a means

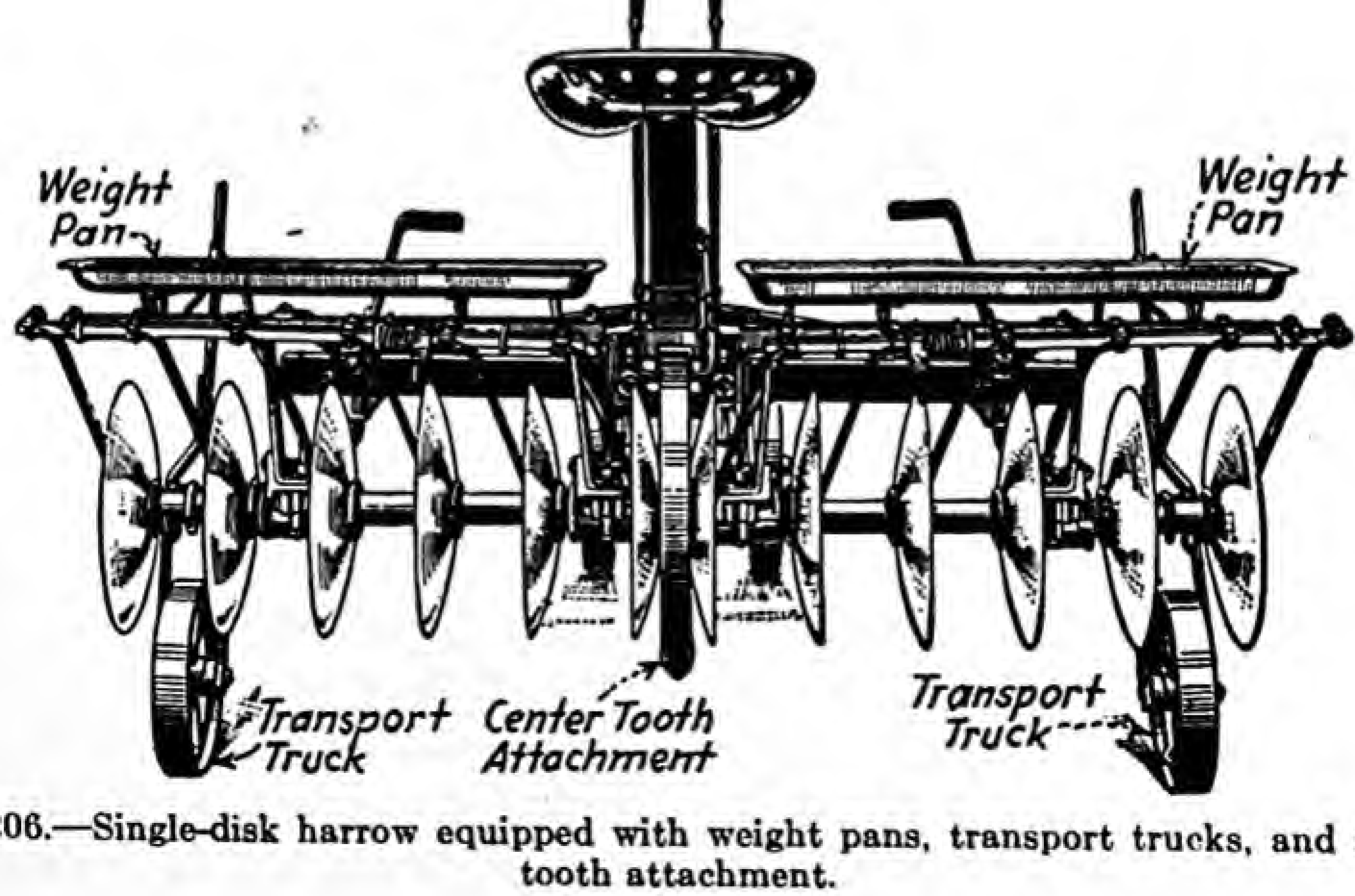


FIG. 206.—Single-disk harrow equipped with weight pans, transport trucks, and center-tooth attachment.

for placing stones or sacks of earth on the harrow, adding weight to force it deeper into the soil. A special weight attachment is shown in Fig. 207.

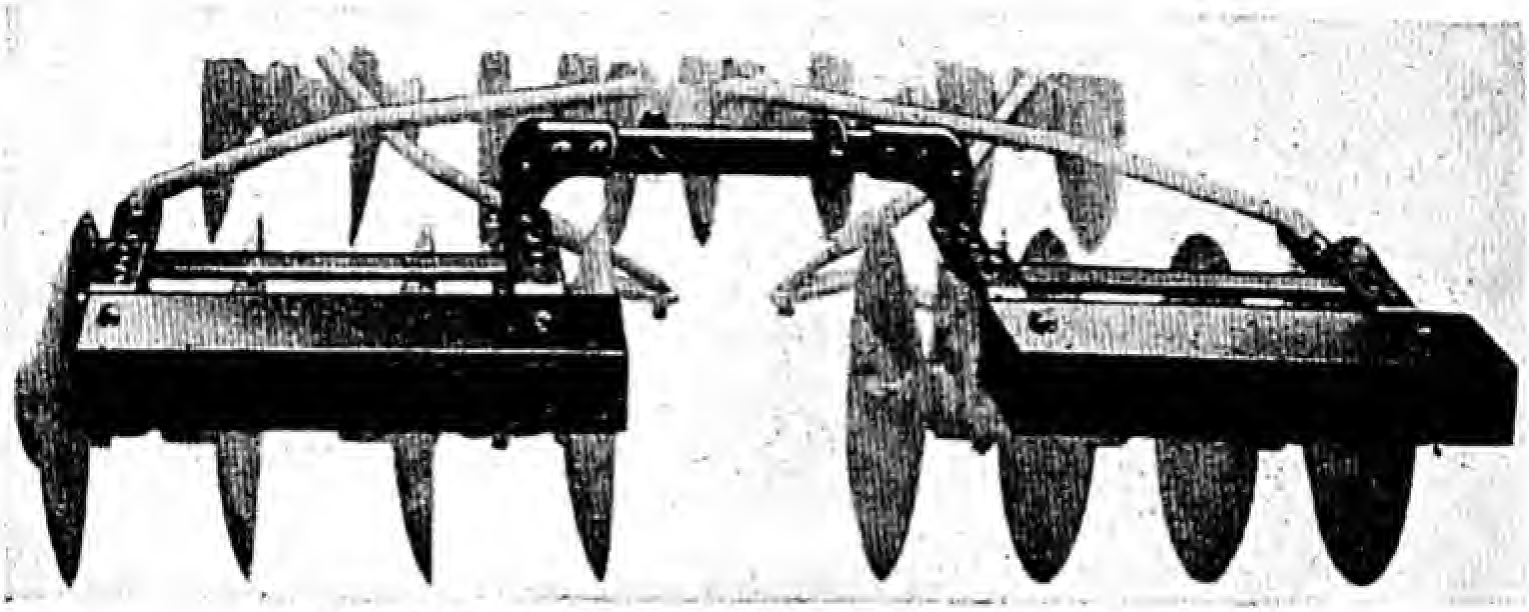


FIG. 207.—Weight attachment for disk harrow.

209. Center-depth Regulator.—When the gangs in single-disk harrows are set to throw the soil from the center, there is always a tendency for the center end to penetrate less than the outer end. By means of a depth regulator additional pressure can be brought to bear on the inner end of the gang, forcing that end deeper into the soil and giving uniform

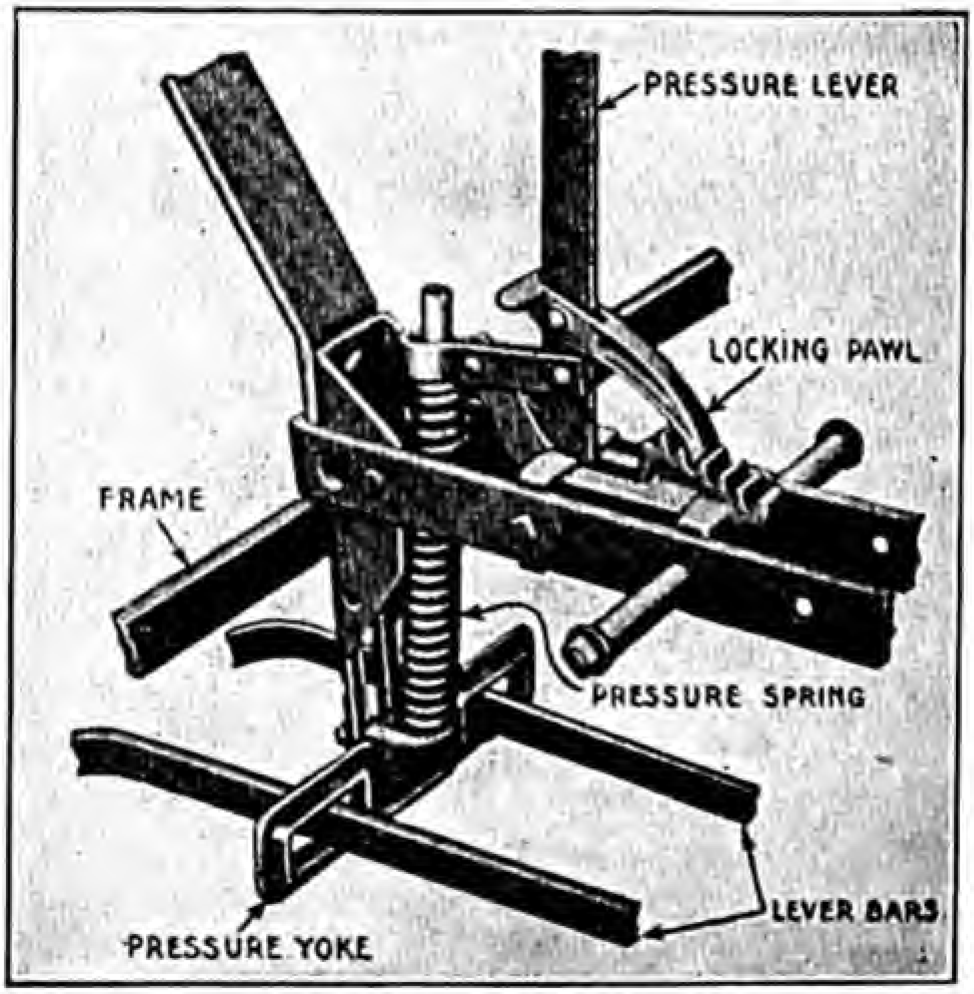


FIG. 208.—Center-depth regulator.

penetration to the entire width of the harrow. This may be done by means of springs or extra brackets called *snubbing blocks,* all of which act on the lever bars, transmitting the force to the gang as shown in Fig. 208. A heavy pressure spring is sometimes used to force the inner end of the disk gang downward. The snubbing block is bolted to the frame and adjusted vertically by means of elongated bolt holes. By

setting the block lower down, additional pressure can be brought to bear on the inner end of the gang.

The rear gangs of double harrows have the reverse action. The outer end kicks up while the inner end digs in. Provision is made on double harrows to hold the inner end up, making uniform penetration.

210. Angling the Gangs.—Ordinarily, when the gang is set straight, the gang bolts are at right angles with the tongue and the disks will not enter the soil. Therefore, penetration is brought about by giving the gang a greater angle. The best penetration is obtained at an angle of approximately 20 degrees. Power angling may be accomplished by backing the tractor until the gangs are at the desired angle. A hydraulic angling arrangement is shown in Fig. 209.

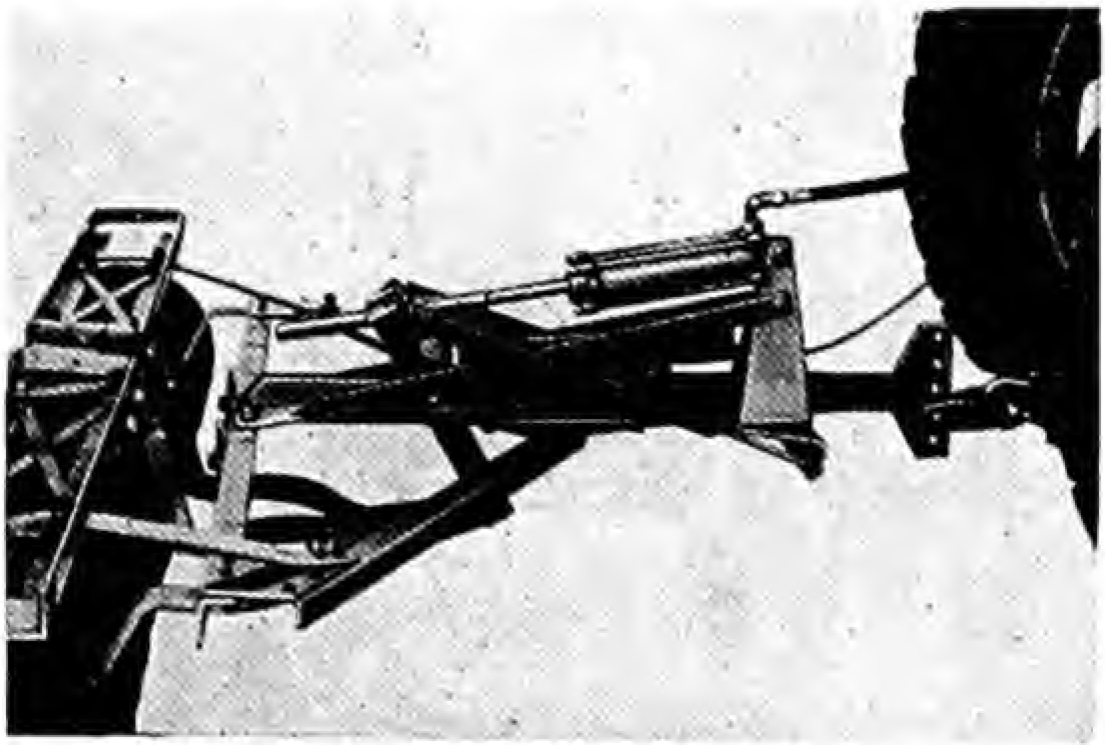


FIG. 209.—Hydraulic power angling for disk harrow.

211. Forecarriage.—Disk harrows for horses are constructed with or without tongues attached. If with a tongue, a large part of the weight of the operator and the frame is carried upon the necks of the horses. If a forecarriage as shown in Fig. 201 is placed under the frame, then there is no weight to be carried on the horses' necks. The principal advantages of the tongue are that better control is maintained over the harrow and shorter turns can be made. However, these features are greatly outweighed by the advantages of the forecarriage, which takes the weight off the horses' necks, eliminates whipping of the tongue, and allows the horses to turn the harrow with the traces rather than with the tongue.

212. Methods of Transportation.—When it is desired to move the harrow any distance, the common method of transporting is to straighten the gangs so that there will be no angle or tendency for the disk to penetrate the soil. If there are any rocks, gravel, or obstructions of any kind, the sharp edges of the disks will be greatly injured and battered

up. A better method of transporting the harrow is by the use of transport trucks, as shown in Fig. 206. These trucks are placed under the gangs, elevating them off the ground so that no damage will be done to the disks. There should be one truck for each gang. These trucks can be obtained with single or double wheels.

213. The Orchard Disk Harrow.—The orchard disk harrow, as shown in Fig. 210, differs from the regular single-disk harrows by having a wide frame so that the gangs can be set at varying distances apart. It is often desirable to cultivate under low-hanging branches. If the team or tractor is driven too close to the trees, fruit may be injured. With an extension frame the gangs can be set far enough to the side so that they will extend under the branches, cultivating the soil without injuring the fruit. Shields can be purchased to cover the disk and prevent the sharp edges from doing any damage.

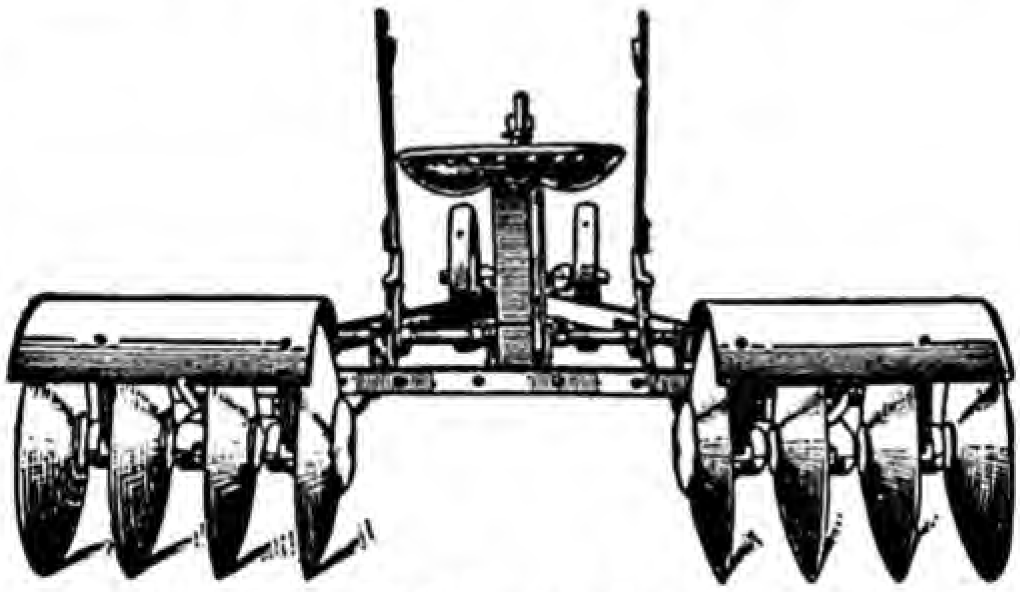


FIG. 210.—Disk harrow for orchards.

214. Reversible-disk Harrows.—The reversible-disk harrow, as shown in Fig. 211, is a single-disk harrow with the gangs constructed in such a manner that they can be reversed to throw the soil either in or out. They are also adjustable for cultivating on ridges. Either end of the gang can be raised or lowered to suit the topography of the soil.

215. The Double-action Disk Harrow.—The double-disk harrow is often called a *tandem* harrow. Two single-disk harrows are attached together, one behind the other. The front gangs throw the soil outward. This, of course, if not followed by other disks to throw the soil inward, will leave the soil unlevel. If only the front gangs are used, half the harrow must be lapped on the next round to accomplish the same result. By the use of the double harrow twice as much is accomplished as when the single harrow is used. The rear disks should split the space left by the disks in front. Very few harrows can be made to accomplish this.

216. Double-action Disks for Horses.—Originally, the double disk was brought out for use behind horses, but it was not long before it was

being made for use with tractors. The horse disk is usually lighter than that used with a tractor. The front gangs are also supplied with fore-

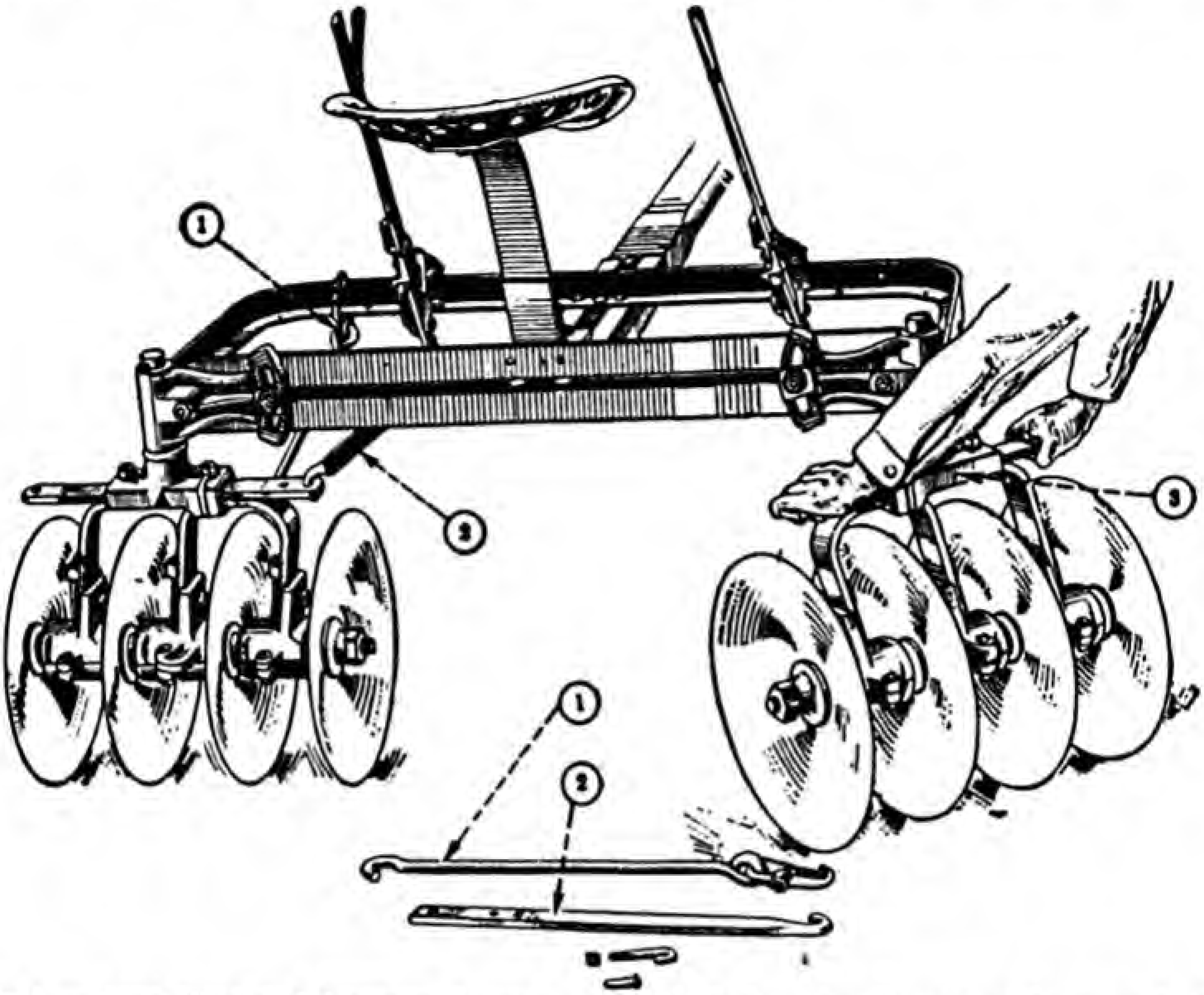


FIG. 211.—Reversible-disk harrow showing method of changing from out-throw to inthrow, or *vice versa*.

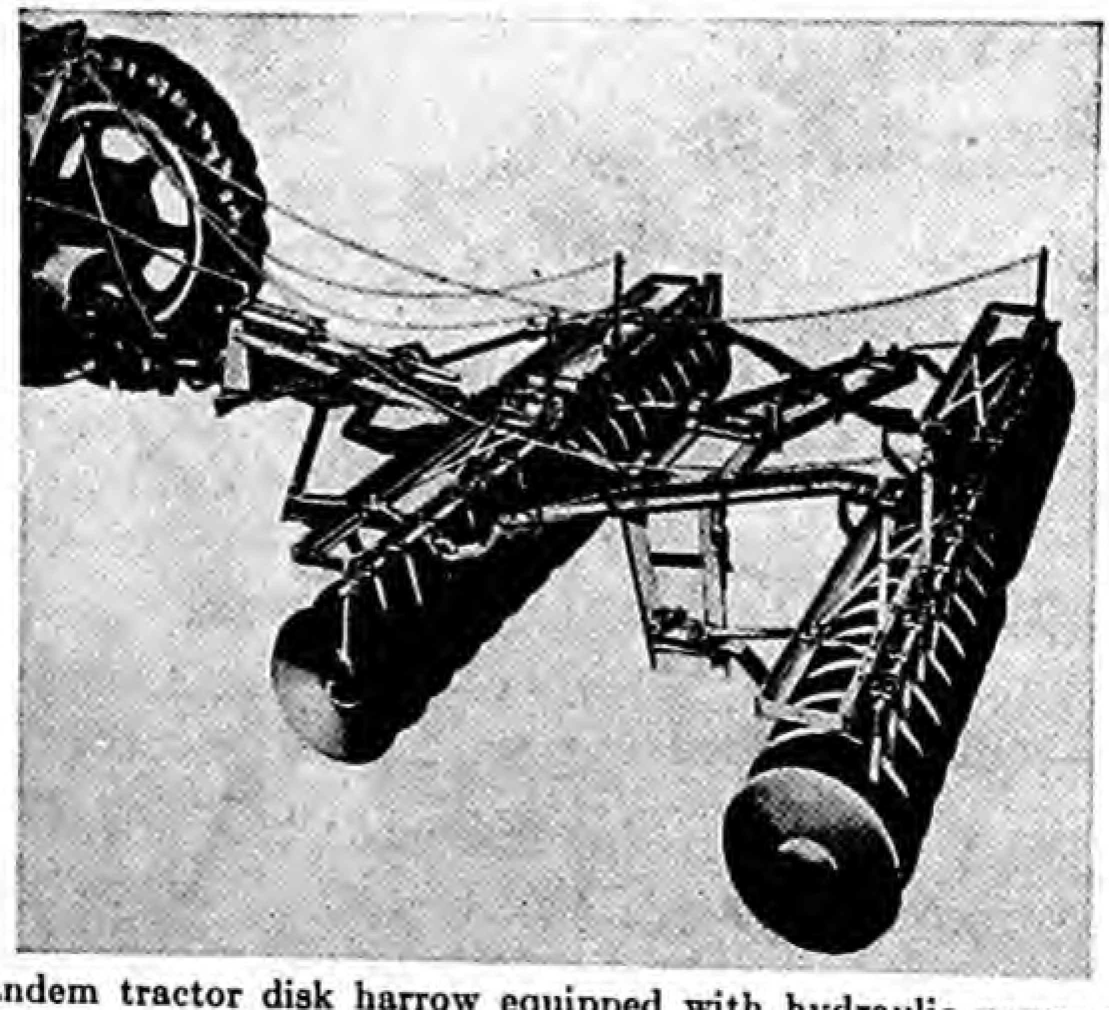


FIG. 212.—Tandem tractor disk harrow equipped with hydraulic power-angling device.

carriages, seats, and levers convenient for the operator who rides upon the harrow.

217. The Tractor Harrow.—Tractor disk harrows, as shown in Figs. 212 and 213, differ from horse harrows in many respects. First, they are heavier. Second, the forecarriage is eliminated, the frame being attached directly to the drawbar. Third, the levers are arranged differently or eliminated entirely. Fourth, the seat is eliminated because the operator rides the tractor. Fifth, many harrows are provided with power-angling devices. Sixth, it is not necessary in turning at the end

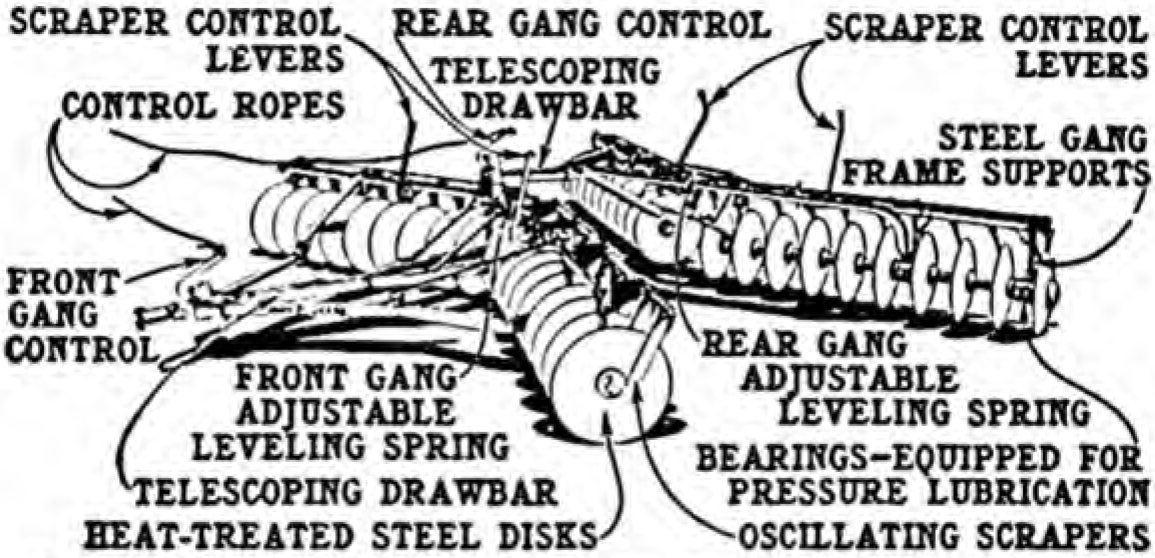


FIG. 213.—Tractor double-action or tandem disk harrow.

to stop and straighten the disk gangs. And seventh, more rigidity in the construction of the harrow can be employed. Single- and double-action tractor disk harrows are provided with extensions of sufficient length that a strip 21 feet wide may be harrowed. The extensions can be folded over on top of the regular gangs to give extra weight and to permit passage through gates (Fig. 214). The various parts of the gang are constructed in the same manner as that described under the single disk,

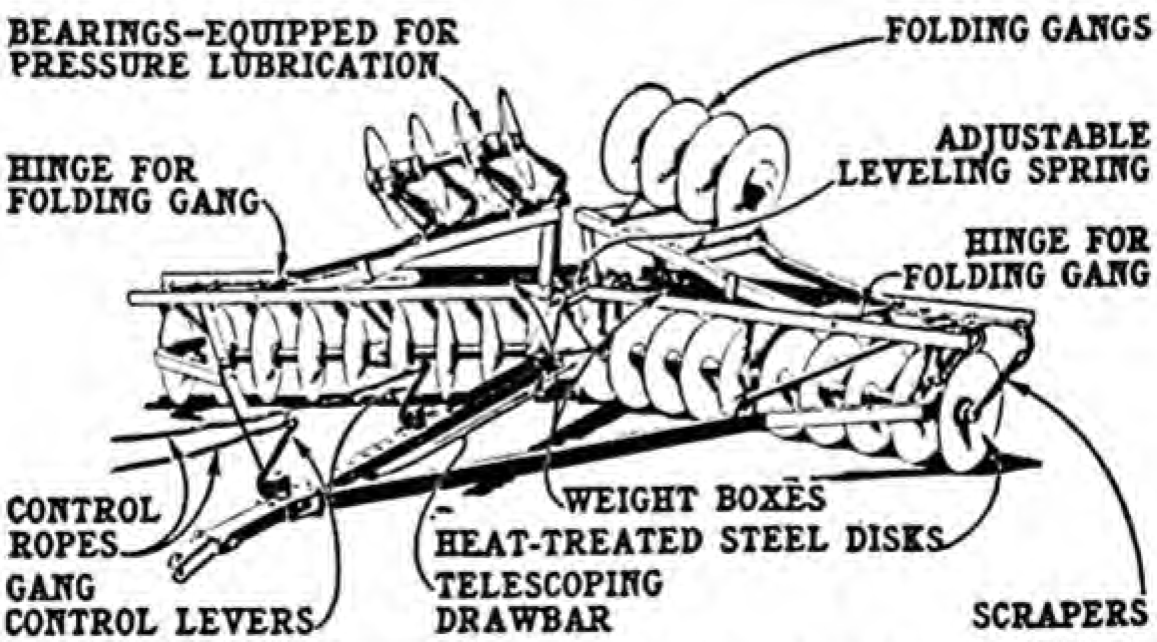


FIG. 214.—Tractor disk harrow, showing extension gangs in folded position.

the only difference being that they are made heavier to withstand the harder use of tractor disking. The two rear gangs are always locked together, preventing them from moving more than a measured distance apart.

218. Offset-disk Harrow.—The offset-disk harrow (Figs. 215 and 216) is adapted for use in orchards and vineyards, as it can be set to

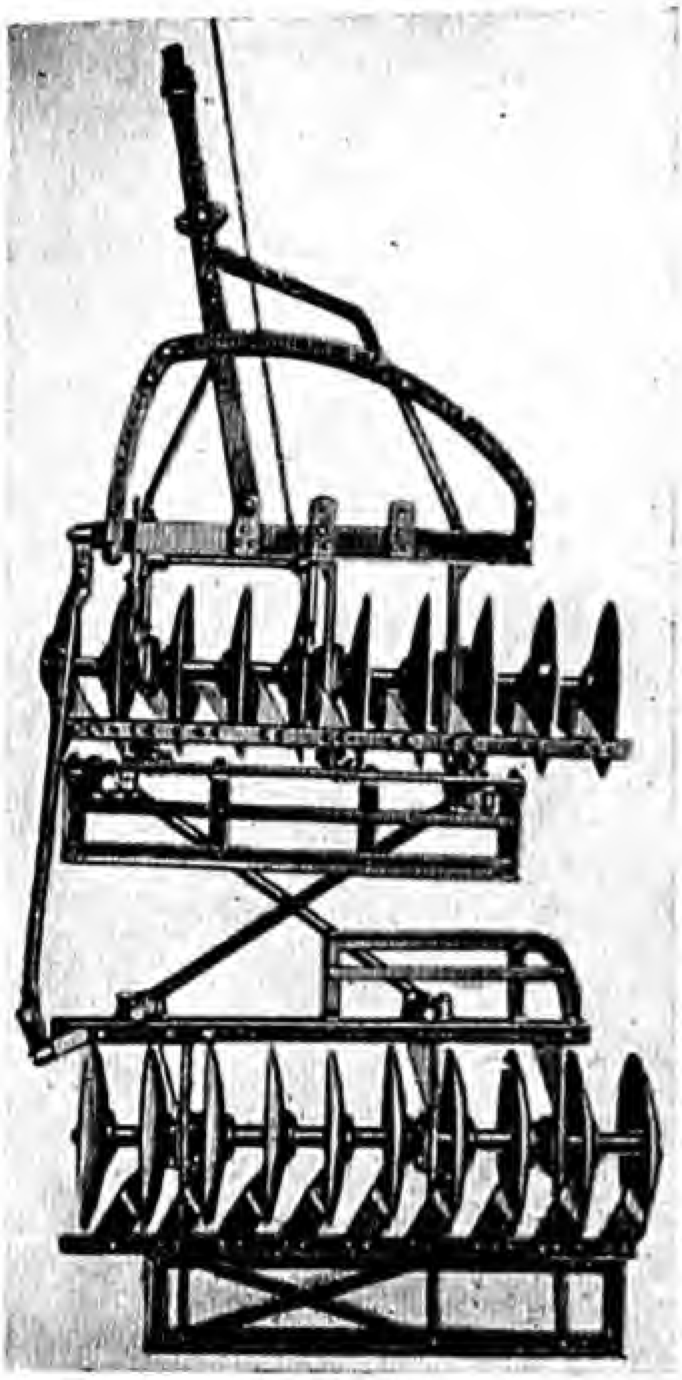


FIG. 215.—Offset-disk harrow.

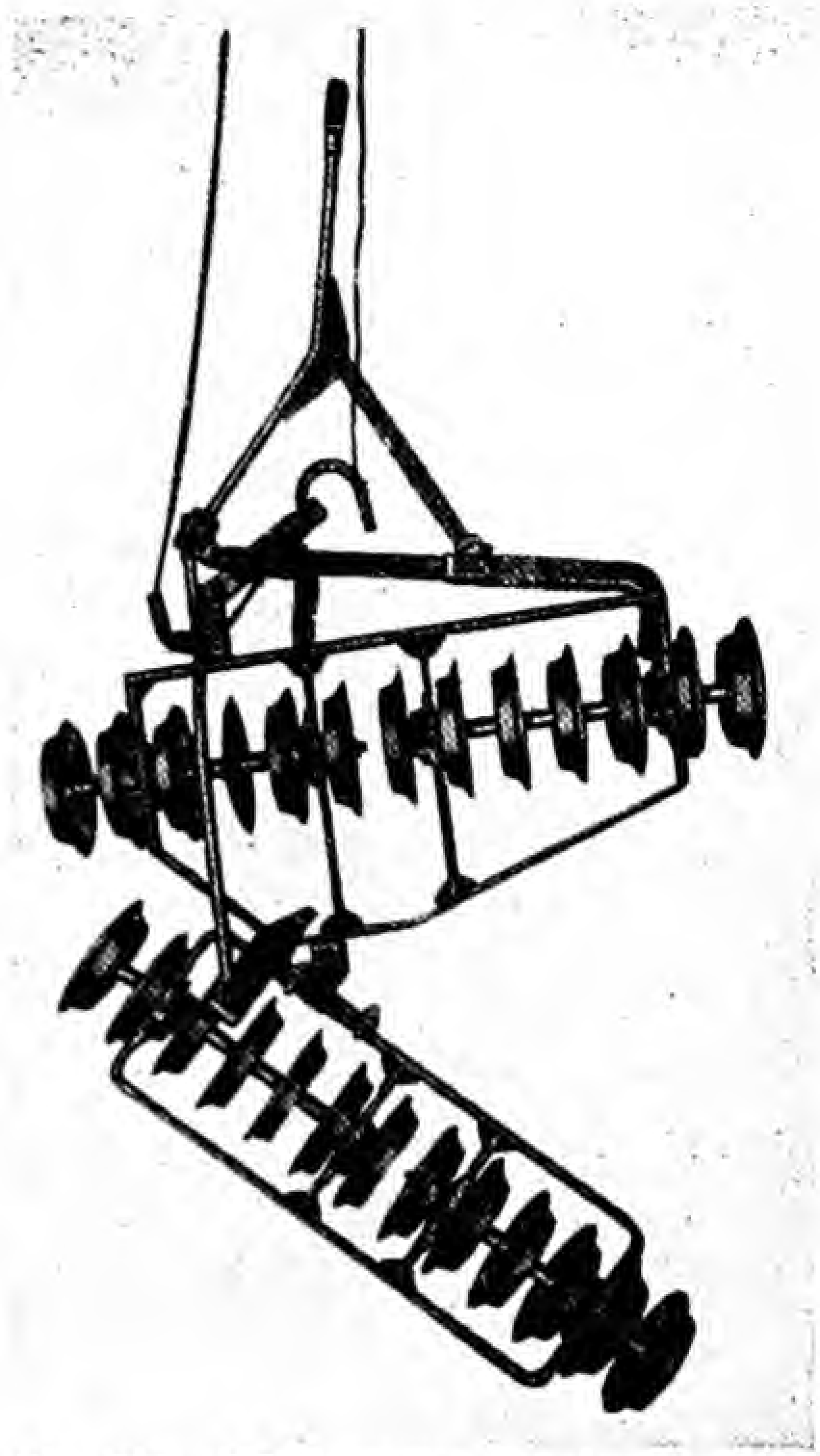


FIG. 216.—Offset tractor disk harrow with depth gages attached to all disks.

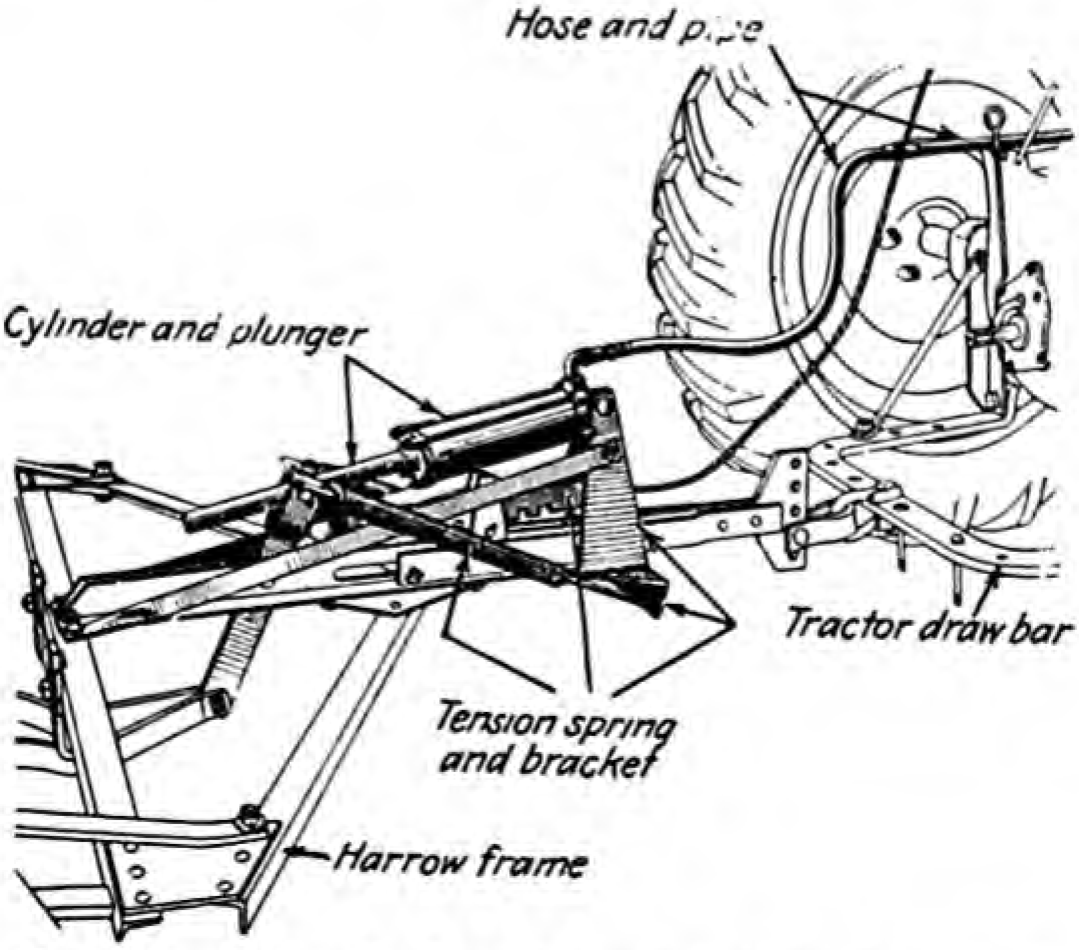


FIG. 217.—Hydraulic de-angling device for disk harrows.

run to the side of the tractor and thus cultivate under branches too low for the tractor to pass under. There are no levers to catch on low limbs. It will work on uneven ground and swing around corners either to the right or to the left. Large disks 18 to 22 inches in diameter are used on this type of harrow to cut up and turn under heavy trash.

219. Power-angling Devices.—The use of disk harrows behind tractors created a demand for a method of angling the gangs without the operator having to get off the tractor seat to change the angle. Several different methods of angling by the tractor power have been developed. Some of these devices operate in a manner similar to the power-lifting devices used on tractor plows. Figure 212 shows a tractor tandem disk harrow equipped with a hydraulic angling arrangement. The various parts for this device are shown in Fig. 217.

220. Soil Penetration of Disk Harrows.—There are many factors within the harrow itself that will influence the depth to which it will penetrate the soil. They are enumerated as follows:

1. The angle of the disk gang.
2. The weight of the harrow.
3. The sharpness of the disks on the gangs.
4. The size of the disks.
5. The concavity of the disks.
6. The angle of the hitch.

All these factors are incorporated within the harrow itself. Other factors, however, that influence the depth of penetration have nothing

FIG. 218.—Crawler-type tractor pulling 16-foot tandem disk harrow and grain drill—disking and seeding in one operation.

to do with the harrow, such as the condition of the soil, the amount of moisture, whether plowed land or unplowed land, the amount of trash on the soil, and the amount of organic matter that may be in the soil.

221. Draft of Disk Harrows.—No definite data can be given on the draft of the disk harrow because there are a number of factors which will influence the draft; many of them are the same as those which will influence the depth of penetration. Naturally, the angle of the disk gang will

cause the disk harrow to go deeper into the soil, resulting in a heavier draft. Tests made by Collins[1] gave the following results:

TABLE IX.—DRAFT OF DISK HARROW, IN POUNDS

	Sod	Plowed sod	Corn stubble	Cornstalks
Full disk	470	610	450	400
Cutaway	550	680	510	480

Both the harrows were 8-foot sizes and just alike, with the exception that one was equipped with 16-inch round disk blades and the other with

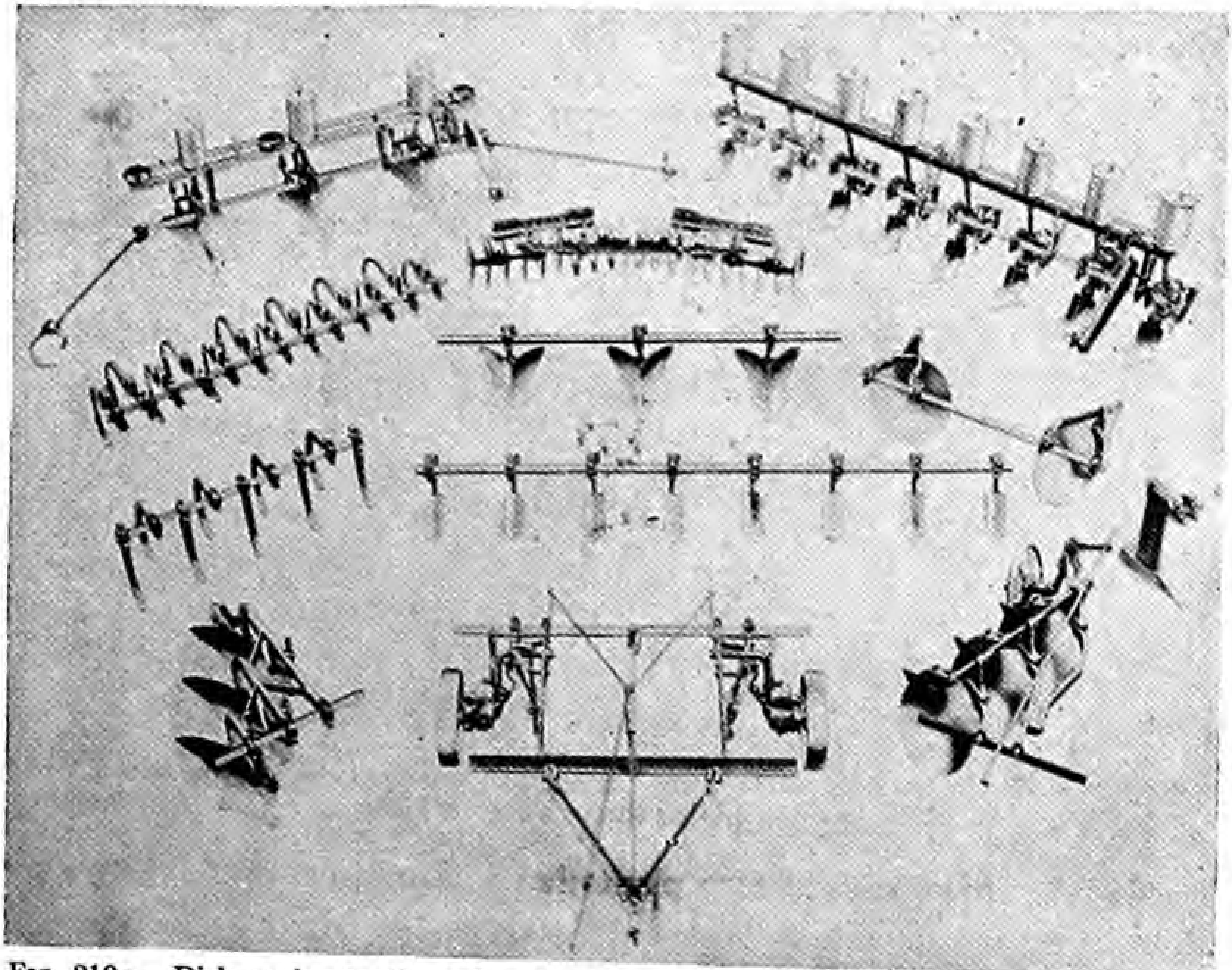


FIG. 219a.—Disk, spring-tooth, and orchard harrows, and other units for tractor tool bar.

16-inch cutaway blades with six points each. The draft of cutaway disks is on an average about 15 per cent heavier than the draft of full-blade disks.

222. Disk-harrow Troubles and Causes.

1. Poor penetration: Hitch too high. Gangs not angled enough. Not enough weight. Scrapers do not clean disk properly. Harrow pulled too fast. Disks dull. Disks not polished.

[1] *Agr. Eng. Jour.*, Vol. II, p. 91, 1921.

2. Uneven penetration or ridging: Gangs not running level. Hitch too high. Rear gangs not angled properly. Rear gangs not spaced correctly.

3. Rear run to one side: Rear gangs not running level. One gang not running free, bearing too tight. Scrapers on one gang too tight.

4. Strip left by front gangs not covered by rear gangs: Harrow pulled too slow. Rear gangs not angled enough. Front gangs not level, inner ends cut too deep. Rear gangs too close together.

5. Harrow chokes: Soil too wet and sticky. Scrapers not set properly. Gangs angled too much. Harrow pulled too slow. Disks not polished. Disks too small.

223. Care of Disk Harrows.—To keep a disk harrow in good working condition and to make it last longer it is essential that it be greased thoroughly one or two times daily. See that all bolts are kept tight and the disks sharp. Don't pull the harrow over gravel or rock-strewn roads. If such roads are unavoidable use transport wheels.

WEEDER-MULCHERS

Weeders are excellent tools for making a mulch, for breaking the soil crust over germinating seeds, and for controlling and destroying young

FIG. 219b.—Weeder-mulcher attachment for tractor; end sections may be tipped up to permit driving through narrow gates.

weeds just after the field-crop plants have begun to grow. Figure 219b shows a weeder-mulcher.

LAND ROLLERS AND PULVERIZERS

224. Kinds and Types of Land Rollers.—Land rollers or pulverizers are tools used for the further preparation of the seedbed. They may be divided into two classes according to the kind of work they do, the *surface packer* and the *subsurface packer*.

There are several different kinds of commercial surface packers and pulverizers, named according to the shape of the roller surface: the V-shaped pulverizer, the combination T-shaped and sprocket-wheel pulverizer, and the flexible sprocket-wheel pulverizer.

The subsurface packers consist of a V-shaped packer and the crow-foot roller.

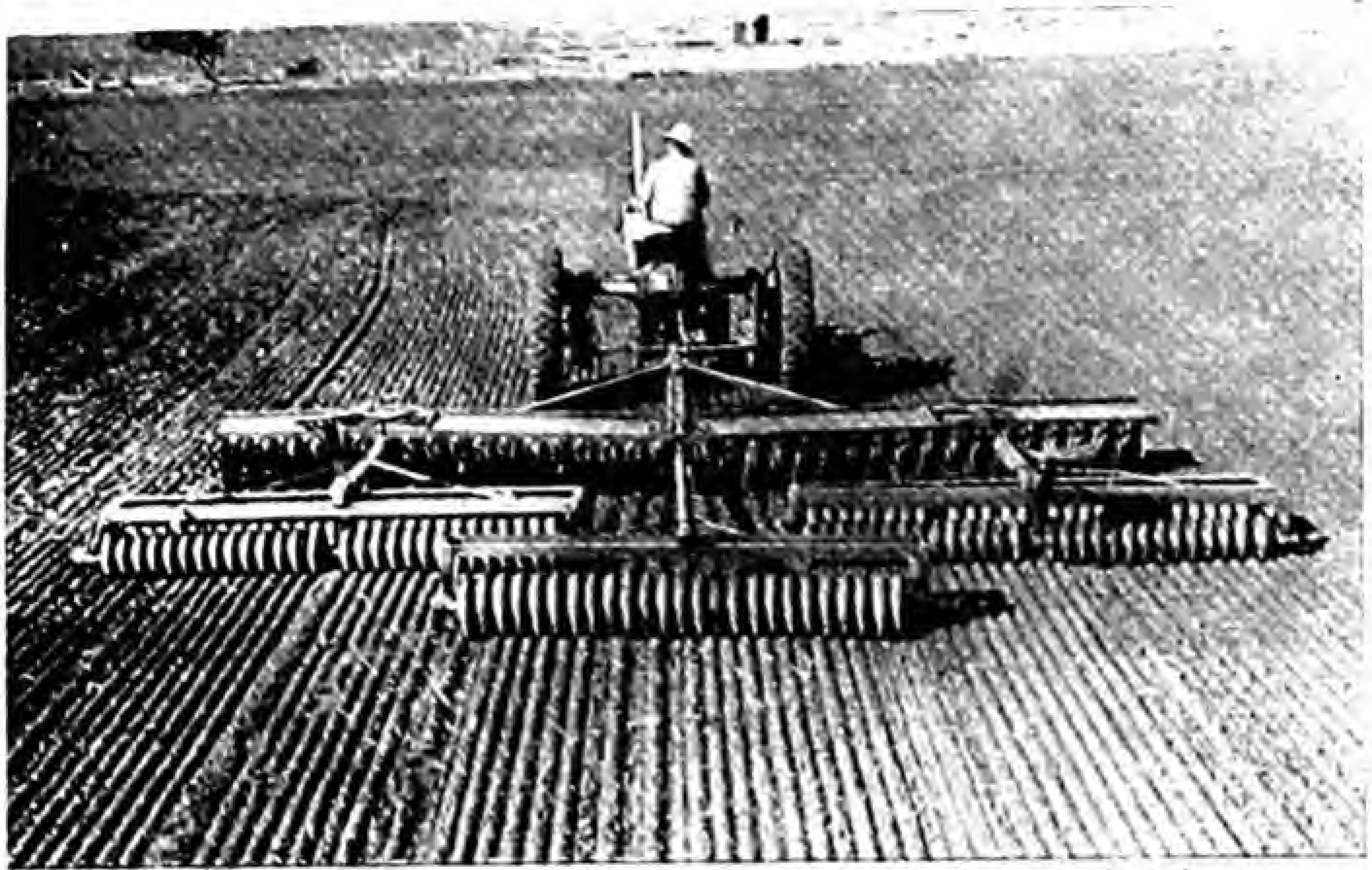


FIG. 220.—Culti-packer land roller in use behind a 21-foot disk harrow.

The surface roller is coming into more general use each year because it has a varied number of uses. The most important is as a clod crusher; at this it has no equal. Another very important use is to finish preparing the seedbed by thoroughly pulverizing and firming the loose soil so that there will not be any large air spaces or pockets. It presses the upper soil down against the subsoil, making a continuous seedbed in which moisture is conserved and given to the roots of the plants as it is needed. Also, when meadow, wheatland, and pasture land have heaved badly from freezing, the land roller is good to press the soil back down around the roots.

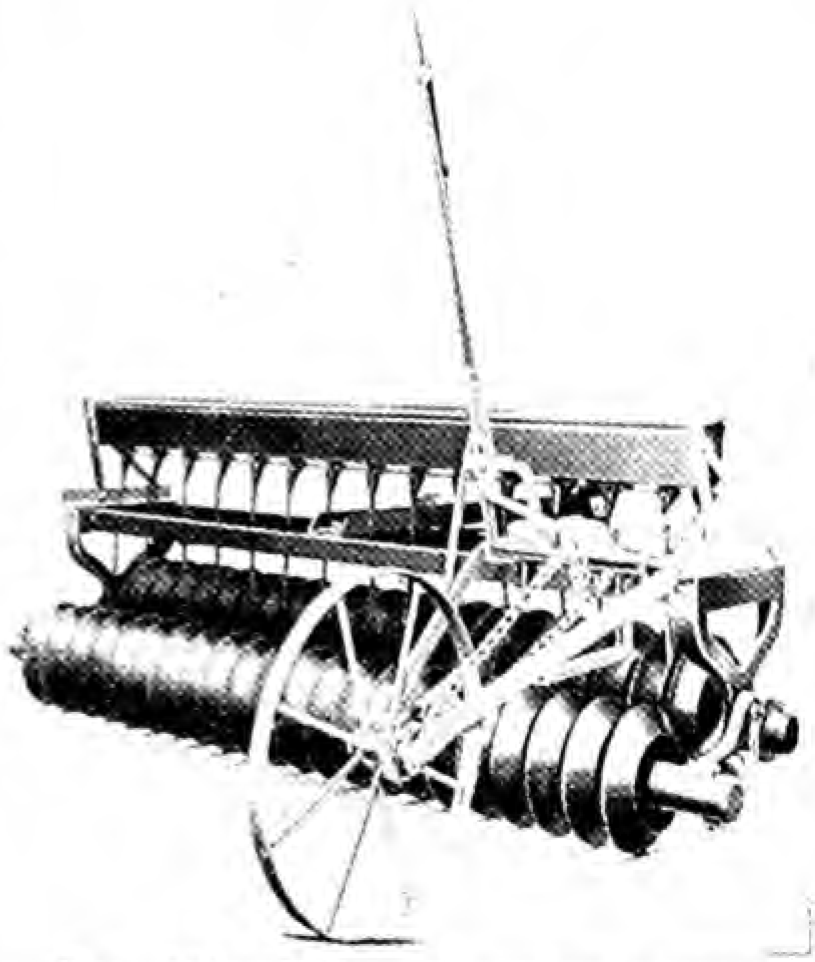


FIG. 221.—V-shaped section pulverizer equipped with grain drill grass-seed attachment.

225a. V-shaped Pulverizer.—The machine shown in Fig. 221 is a roller-pulverizer constructed of a number of wheel sections, so that when they are strung on a shaft the surfaces of the rollers form a kind of corrugation. It is from the shape of the surface it leaves that it gets the name

of *corrugated* roller. Each wheel or section is about 5 or 6 inches thick and varies in diameter from 10 to 18 inches. The roller is hollow. It may consist of one or two pieces and is cast out of semisteel. When placed upon a shaft and rolled across the soil, it leaves small ridges. If only one set of rollers is used, these ridges will be rather large, being 5 or 6 inches from one crown to the other. The common method, however, is to use a rear set of rollers so arranged that they will split the ridge made by the front pair, leaving a number of very fine ridges. It is claimed that this type of roller to a certain extent will prevent wind blowing. It also rolls, pulverizes, packs, levels, cultivates, and mulches the soil in one operation.

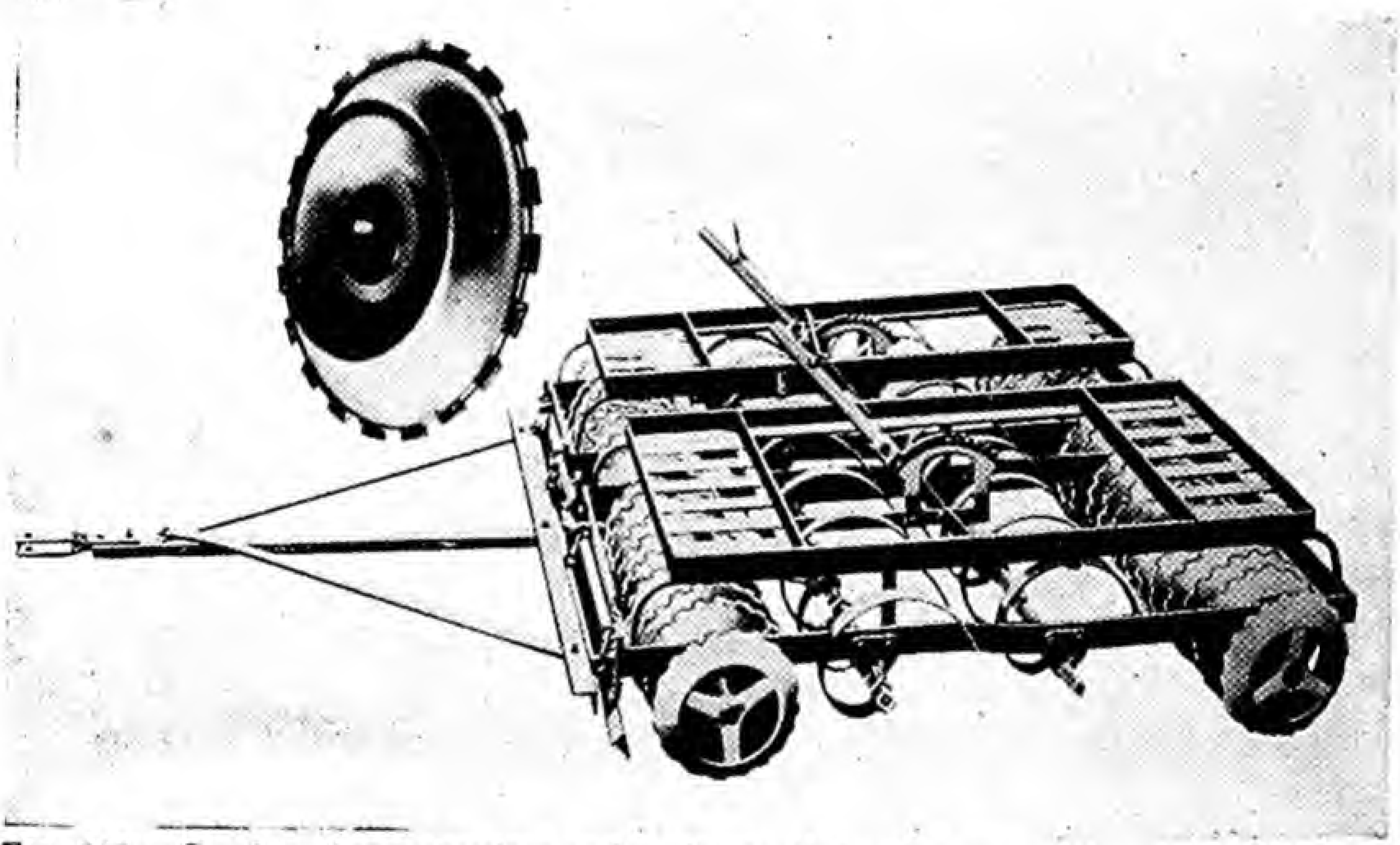


FIG. 222.—Combination pulverizer and spring-tooth harrow or mulcher with leveling bar on frame in front.

Figure 222 shows a roller-pulverizer equipped with V-shaped sections which have serrated edges. The front and rear roller gangs are spaced a few feet apart, and spring harrow teeth are mounted between the sections to harrow the soil and bring clods to the surface so they can be crushed by the rear roller gang.

225b. Combination T-shaped and Sprocket-wheel Pulverizer.—This type of roller-pulverizer has alternate T-shaped and sprocket-wheel sections assembled on a shaft (Fig. 223). T-shaped wheels crush and pulverize the soil while the sprocket-like wheels give a mulching effect, leaving loose pulverized soil on the surface.

226. Flexible Sprocket-wheel Pulverizer.—Figure 224 shows a roller-mulcher-tiller with pulverizer sprocket-like wheels mounted so that they

are flexible and adjust themselves automatically to a surface that is not level.

227. Homemade Rollers.—Many farmers do not care to go to the expense of buying a commercial type of land roller and will make one

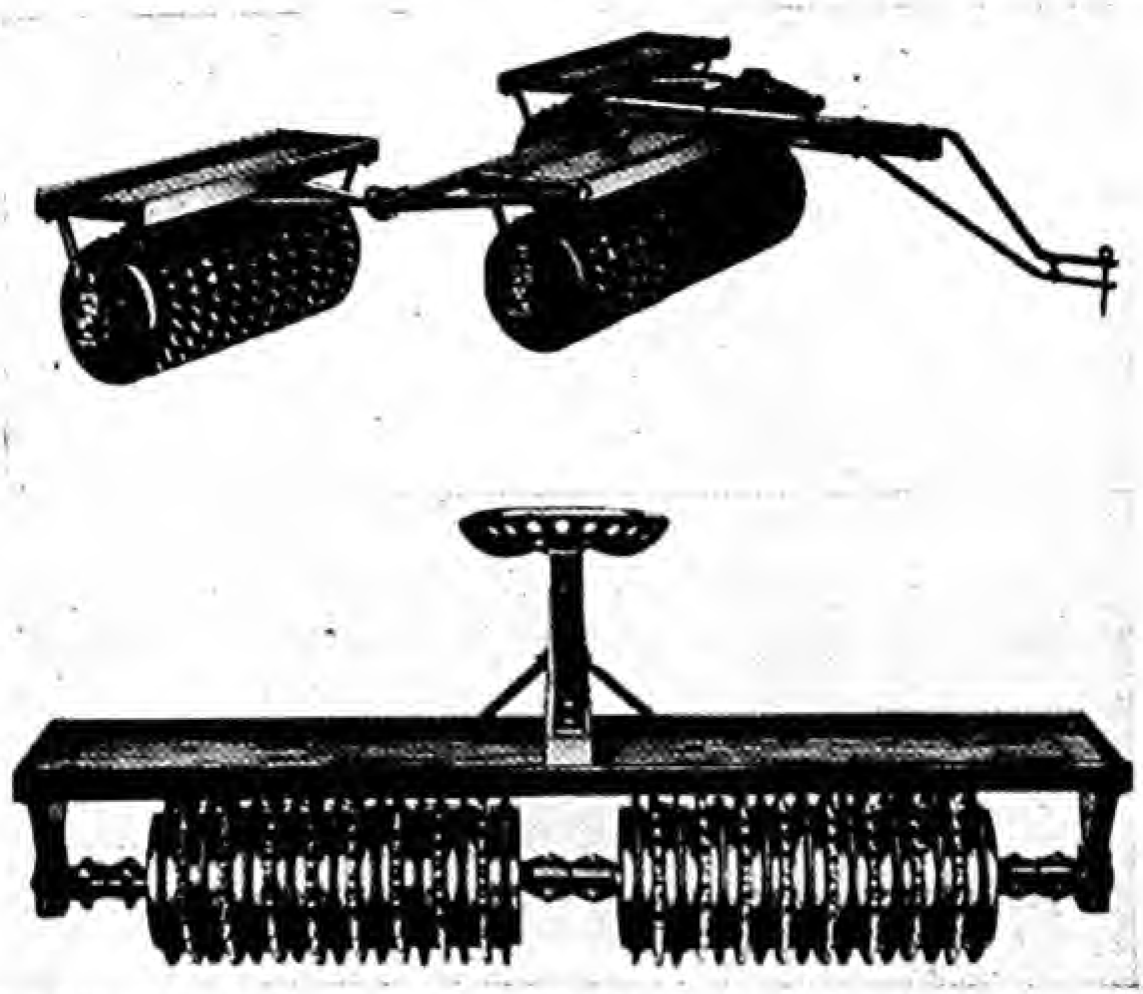


FIG. 223.—Combination roller-mulcher. Roller-packer wheels and mulcher wheel are alternately assembled on the shaft. The inset shows wheels spaced to work row crops.

to serve the purpose from material that can be had on the farm. The principal types of homemade land rollers are the log roller and concrete rollers.

228. Log Roller.—The log roller is a common homemade type found on the farm. It consists of a round smooth log with two spikes placed

FIG. 224.—Flexible roller-mulcher-tiller, rolling potato beds.

in the ends and a frame built to provide a means of attaching the tongue and eveners. Log rollers should not be very long because when turning, if a wide circle is not made, one end will remain stationary while the other

is pulled around. Turning in this manner will have a tendency to dig holes with one end of the roller. It is better, therefore, to use short sections and hinge them together with a knuckle joint of some kind. Such an arrangement will allow easier turning.

229. Homemade Concrete Rollers.—Smooth, round, concrete drum rollers can be made by pouring concrete in a form. This, of course, makes a very heavy roller, requiring quite a large amount of power to pull it. Wooden forms can be easily constructed to make concrete rollers with V-shaped surfaces. The rollers are strung on a shaft in the same manner as on the commercial type.

230. Subsurface Packer Rollers.—It is often desirable to pack the subsurface of the soil. Special tools for doing this are called *subsurface packers.* One common type resembles closely the culti-packer. It consists of a number of wheels with V-shaped rims strung on an axle with the frame overhead in the same manner as the culti-packer, but instead of the rims of the wheels setting close together, there is an interval of several inches between them (Fig. 225). The rims of these wheels are

TABLE X.—SOIL MOISTURE CONTENT IN ACRE-INCHES TO A DEPTH OF 4 FEET IN THE SPRING OF THE CROP YEAR AFTER THE FALLOW PERIOD, OF FALLOW PLOWED ON THREE SPRING DATES, WITH AND WITHOUT SUBSEQUENT SUBSURFACE PACKING, ADAMS BRANCH EXPERIMENT STATION, LIND, WASHINGTON, 1918–1923, INCLUSIVE[1]

Tillage treatment	Soil moisture in acre-inches								Relative amount of conserved moisture
	1918	1919	1920	1921	1922	1923	Average	Conserved moisture[2]	
Early spring plowing:									
Packed	4.91	5.72	5.20	6.03	5.93	5.26	5.51	3.43	101
Not packed	4.95	6.22	4.94	5.29	6.01	5.45	5.48	3.40	100
Intermediate spring plowing:									
Packed	5.06	5.89	5.33	5.93	5.71	5.31	5.54	3.46	102
Not packed	4.67	5.91	5.16	5.50	5.86	5.75	5.47	3.39	100
Late spring plowing:									
Packed	4.71	6.28	5.26	5.44	5.46	5.26	5.40	3.32	98
Not packed	5.09	6.40	5.06	5.28	5.65	5.22	5.45	3.37	99

NOTE.—All plots were disked at the early spring date and plowed as indicated. The packed plots were packed with a Campbell subsurface packer weighted to 30 pounds per wheel. All were immediately cultivated with a spring-tooth harrow. Subsequent tillage was given as necessary for weed control.

[1] *Wash. Agr. Expt. Sta. Bull.* 183, 1924.

[2] Residual moisture to a depth of 4 feet, 2.08 inches, 4-year average.

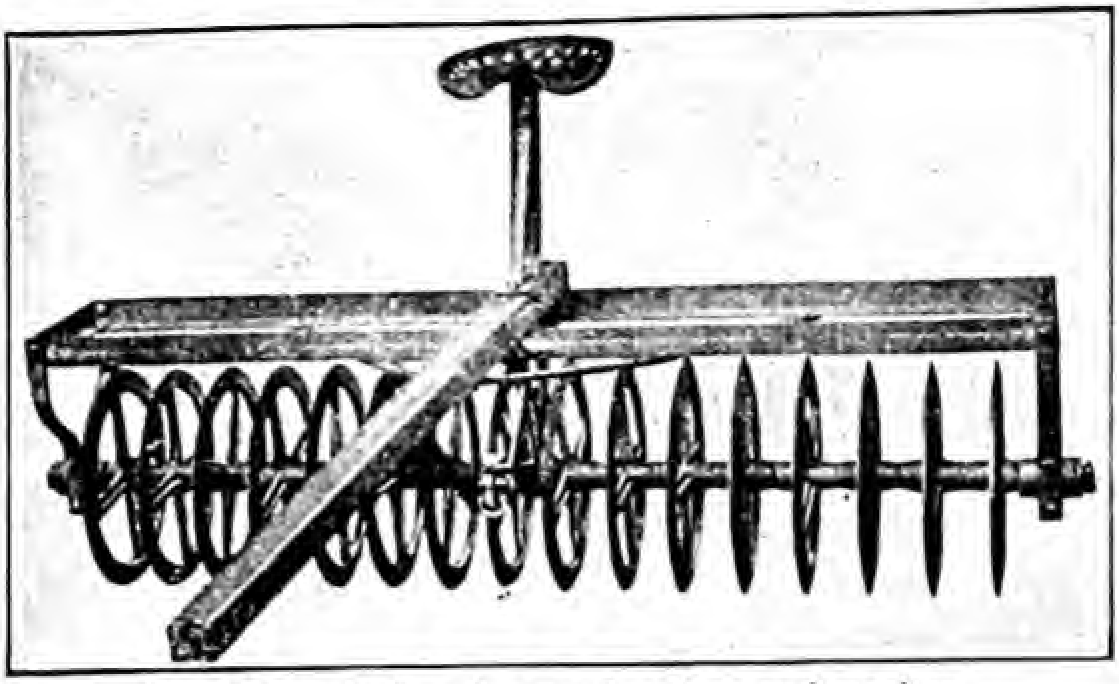


FIG. 225.—Subsurface pulverizer and packer.

FIG. 226.—Subsurface packer.

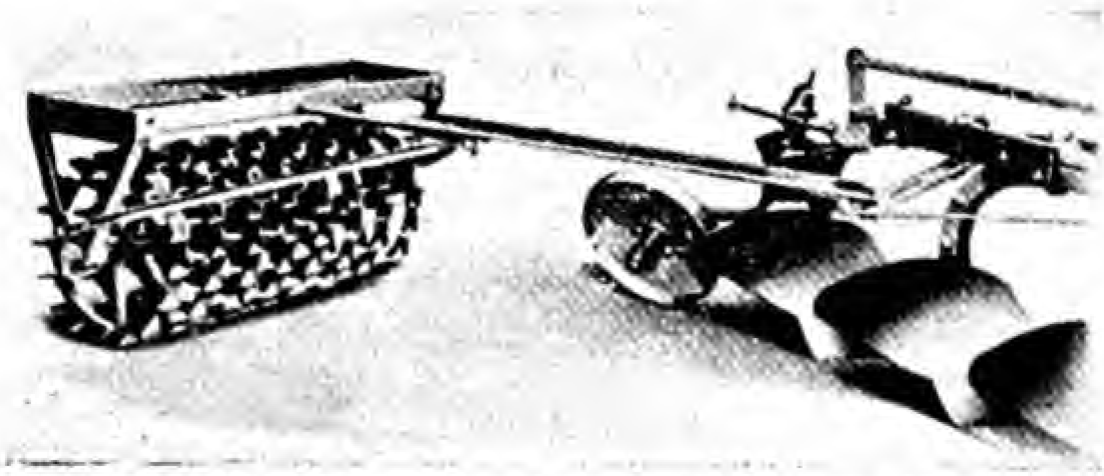


FIG. 227.—Packer attachment for tractor plows.

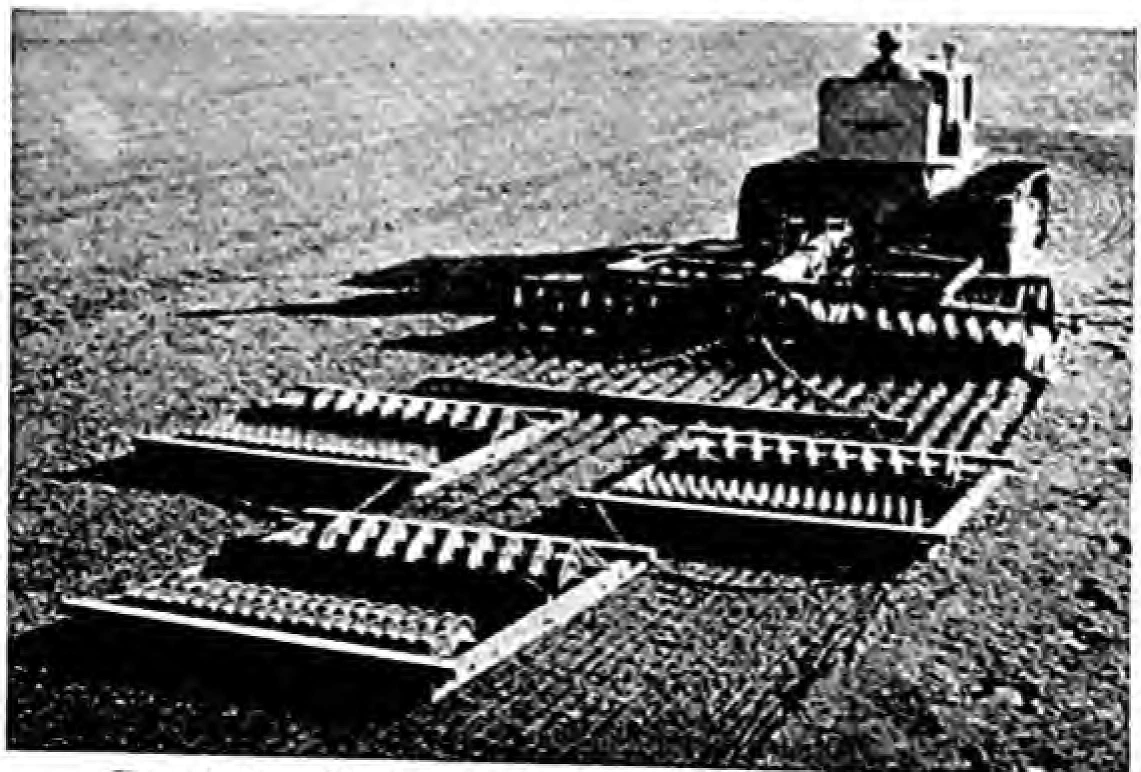


FIG. 228.—Meeker harrow following disk harrow.

also rather narrow. Their V shape allows them to go below the surface, pressing the soil together and leaving a good mulch on top. Another roller which may be classed as a subsurface packer is shown in Fig. 226. The results of conserving moisture by subsurface packing are shown in Table X.

Figure 228 shows a *Meeker harrow* in use behind a disk harrow. The Meeker harrow consists of a large number of disks uniformly spaced on an axle and mounted in a frame. A very fine mulch can be made with this implement.

231. Drags.—In the preparation of a good seedbed, excellent work can be done by the use of ordinary drags which will crush clods, level the land, and firm the soil around the seed. In many cases the drag can be made to take the place of the roller. There are no commercial types of drags, but any farmer can build an ordinary homemade drag that will serve his purpose. The most common drag is the *plank*, which consists of a number of 2 by 8's or 2 by 10's, or any convenient size of plank, lapped upon one another and firmly fastened by cross sills. Many other types of homemade drags too numerous to mention can be made.

SUBSURFACE TILLAGE TOOLS

The control of wind and water erosion and the conservation of moisture in the Great Plains region of the Middle West have brought about the development of new farming practices and new farm tools. The objective is to till the soil in such a manner that the crop residue will be left on the surface. This method of farming is known by several different names, such as *plowless farming, trash farming, stubble mulch, residue management,* and *subsurface tillage.* In the opinion of the writer, subsurface tillage appears to be the most appropriate name, as all the tools used in the operations stir and till the soil beneath the surface and under the trash.

The advantages listed for this method of farming are

1. Increase in the capacity of the soil to absorb water.
2. Reduction of runoff.
3. Reduction of water and wind erosion.
4. Reduction of rate of surface evaporation.

On the other hand, many farmers say that the stubble mulch is hard to handle because it makes it difficult to destroy undesirable vegetation, to develop a good seedbed, and to plant, and under some conditions it increases operation costs. Subsurface tillage requires considerable "know-how" and skill in operation of the tools used. Certain areas and soils are definitely not suited to this system of farming. For example, in the more moist areas there is the danger of increased insect population.

Implements that operate under and do not materially disturb the trash on or near the surface are used most effectively for subsurface tillage. The tools that meet these requirements are *sweeps* and *rod weeders.*

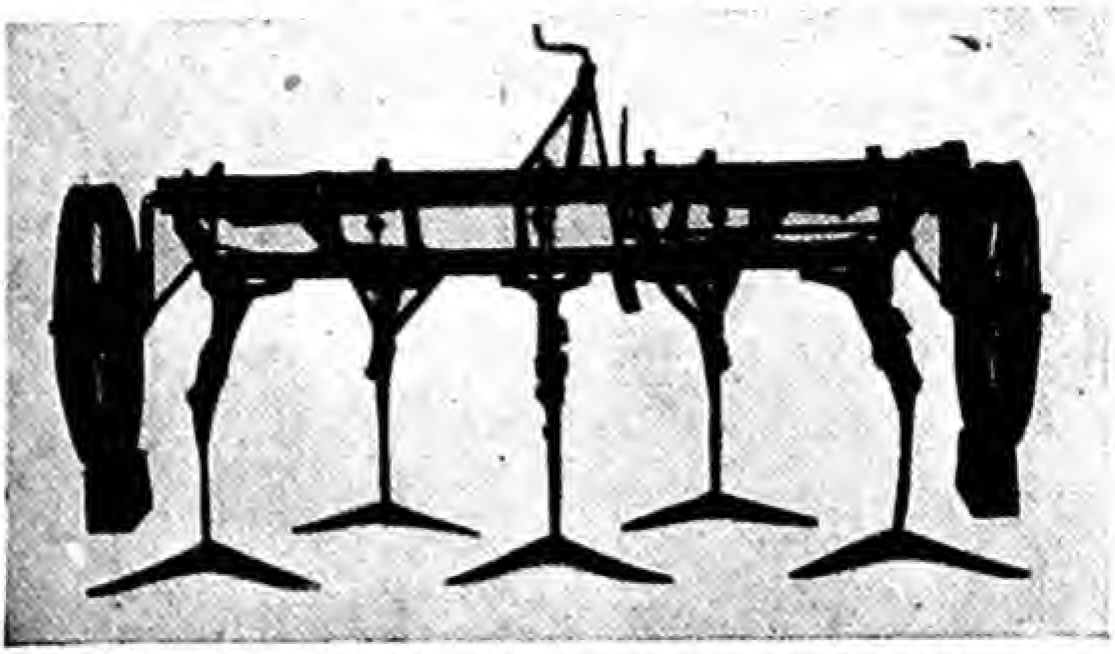


Fig. 229.—Field cultivator equipped with narrow standards and sweeps for subsurface tillage.

232. Subsurface Tillage Sweeps.—To work under trash, sweeps must be set almost flat, mounted on strong narrow standards that are staggered on the frame far enough apart to permit trash to flow around and between the standards. The complete tool is frequently called a *field cultivator*

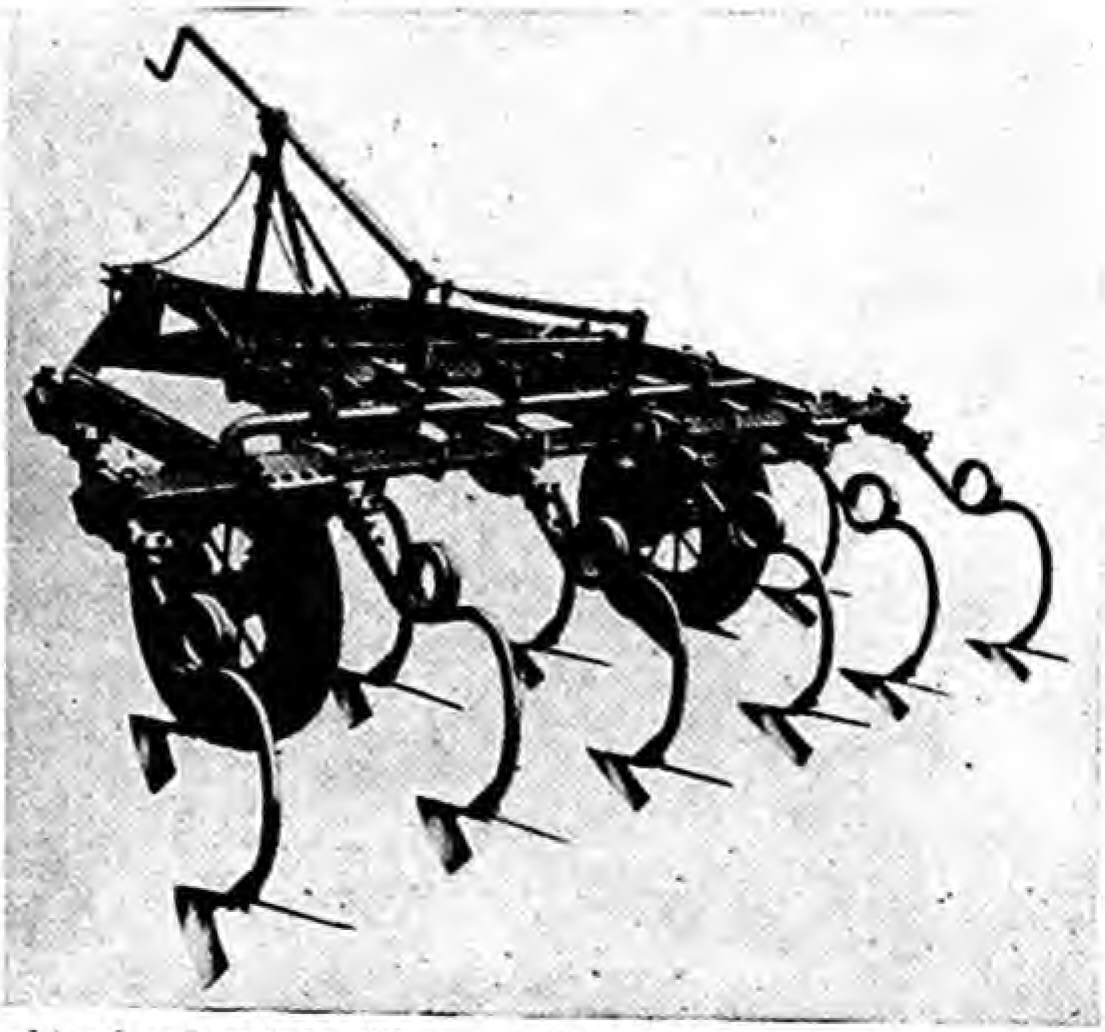


Fig. 230.—Combined subsurface tiller and field cultivator equipped with high-carbon spring-steel high-clearance standards and duckfoot sweeps.

(Figs. 229 and 230). Tractor-drawn machines with subsurface tillage gangs (Fig. 231) and sweeps are provided with depth regulators and power lift and may be obtained in widths ranging from 5½ to 15 feet, depending on type of work to be done.

Where the tool is used for summer fallowing, the spring teeth have 6-inch spacings, while the stiff standards have a 9-inch spacing. If row crops are to be cultivated, the standards can be spaced to suit the row

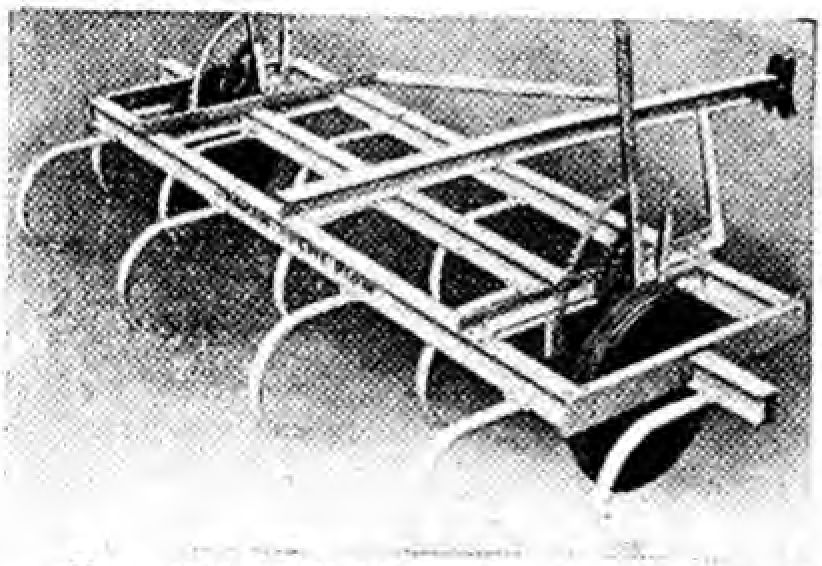


FIG. 231.—Field cultivator equipped with heavy spring-tooth standards and narrow shovels for deep tillage and heavy soils.

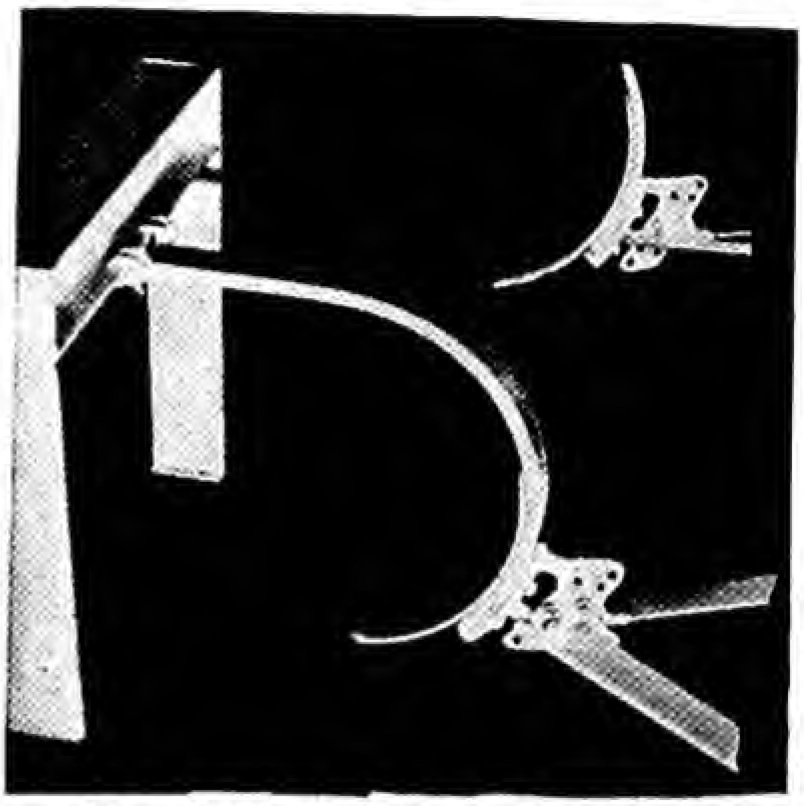


FIG. 232.—Heavy spring-tooth standard equipped with bracket so that sweep wings of different length can be used and set at different angles.

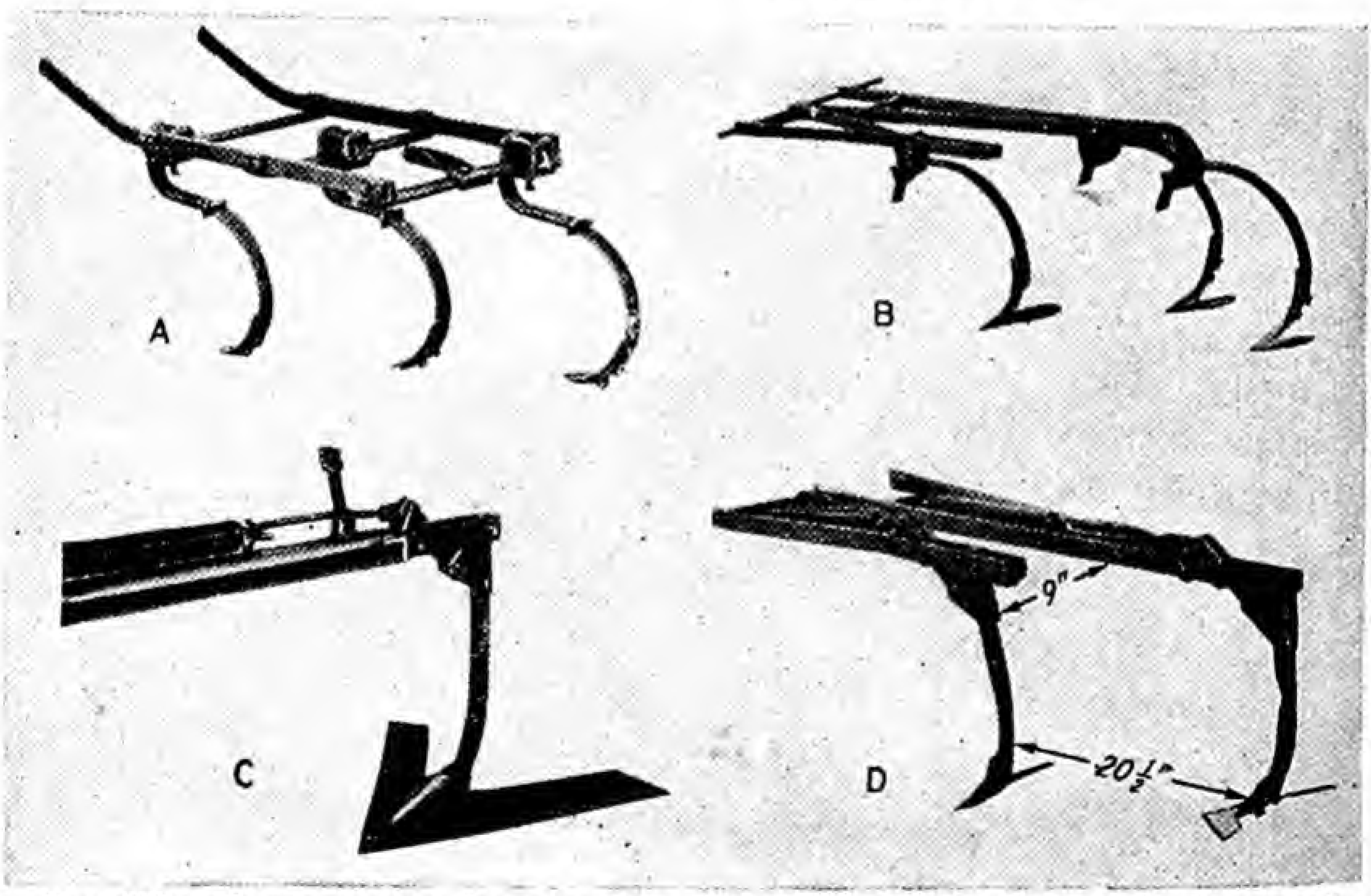


FIG. 233.—Types of gangs for subsurface tillage: *A*, heavy spring teeth for heavy soils; *B*, light spring teeth for light soils; *C*, subsurface tillage sweep bolted to a narrow standard; *D*, high-clearance standards.

width. Trash must not be allowed to collect on the standards, to drag, or to cover small plants. To prevent this, large 16- to 22-inch sweeps are used in connection with notched-edge rolling coulters and concave

disk hillers. To prevent covering small plants large rolling coulters are used on each side of the row to serve as fenders or shields.

FIG. 234.—Tool-bar subsurface tillage assembly of three sweeps provided with rolling coulters.

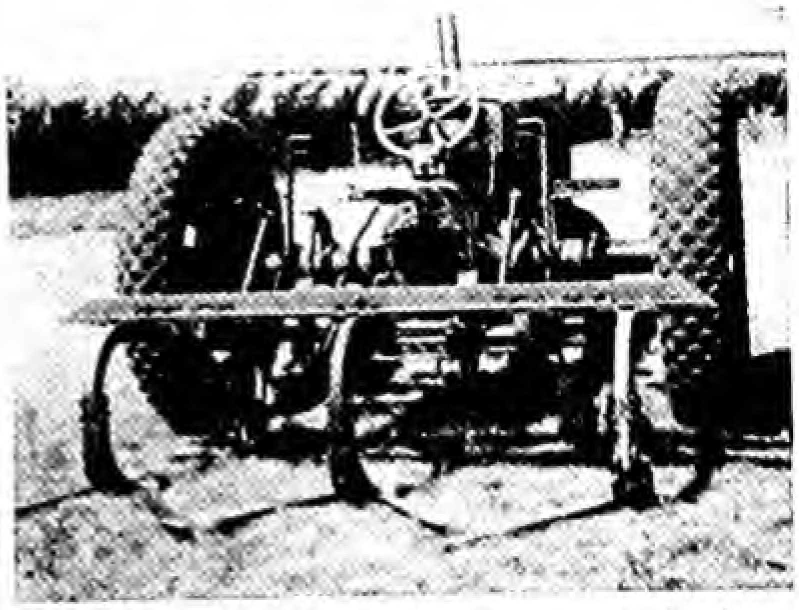


FIG. 235.—Large sweeps attached to three-row lister. Used to cultivate underneath wheat stubble. The two outside sweeps are 42 inches wide while the center one is 36 inches wide. The spacing between sweep points is 36 inches.

233. Subsurface Tillage Rod Weeders.—Rod weeders are used extensively throughout the wheat-growing region of the Great Plains of the United States and Canada. They are used almost exclusively for controlling weed and voluntary vegetative growth on lands where summer fallowing is practiced.

The average rod weeder (Fig. 236) consists of a sturdy frame with four to five plowlike beams which have a shoe or slip nose on each point. Extending through a bearing in the shoes are round or square high-carbon

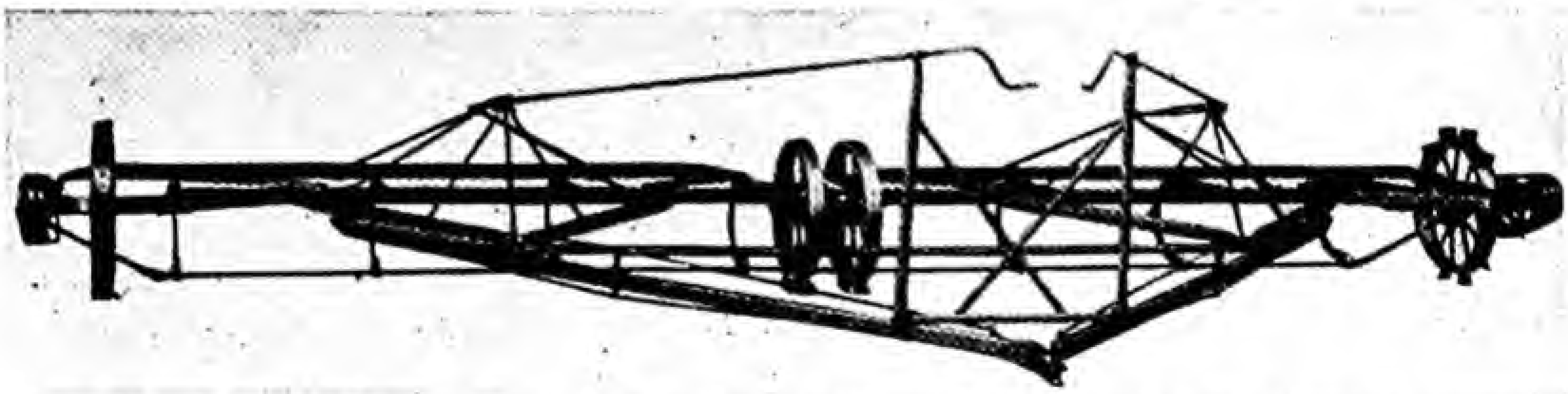


FIG. 236.—Two 12-foot rod weeders make a 24-foot duplex machine. Note the special pyramid-braced tractor hitch.

steel rods that revolve slowly (Fig. 237). The rods are driven by a combination of sprocket chain and gear drive from one wheel (Fig. 238). A lever or screw-type depth regulator is provided. The wheels on each end vary in diameter from 18 to 38 inches, depending on the width of the machine. The rod drive wheel is provided with lugs. The width of single units ranges from 8 to 12 feet; duplex units 18 to 24 feet (Fig. 236); and triplex units 36 feet.

In operation, the revolving rod runs a few inches beneath the surface pulling up and destroying all vegetative growth. The rod revolves to prevent the roots of plants from hanging onto it. The front side of the

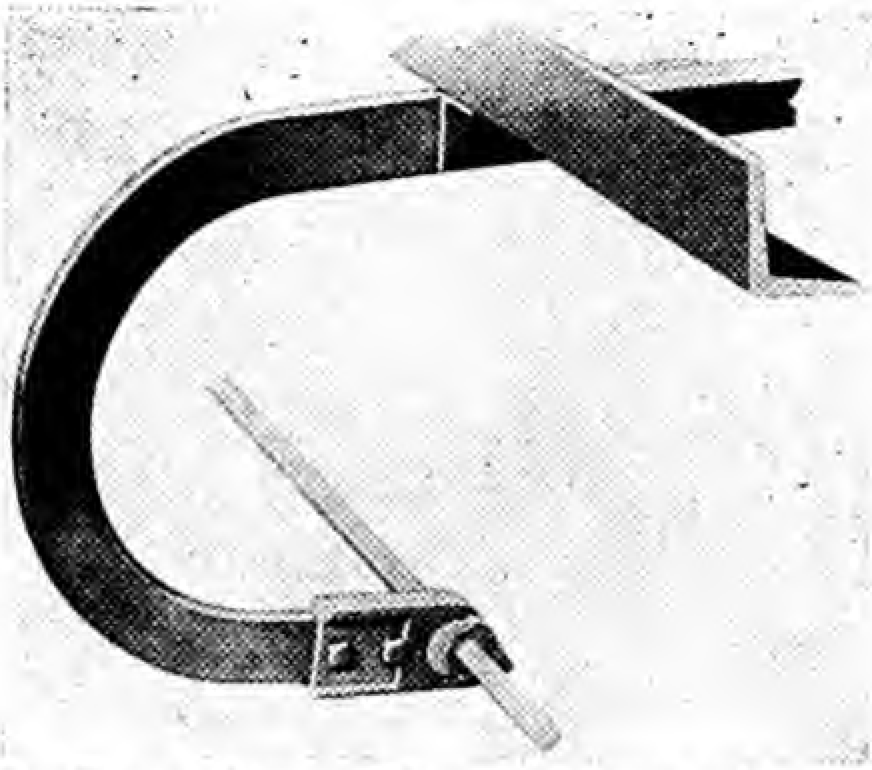


FIG. 237.—Beam, shoe, and bearing square rod-weeder rods.

rod moves upward to pull up and shed the roots of plants. Therefore, a reversing drive is provided (Fig. 238).

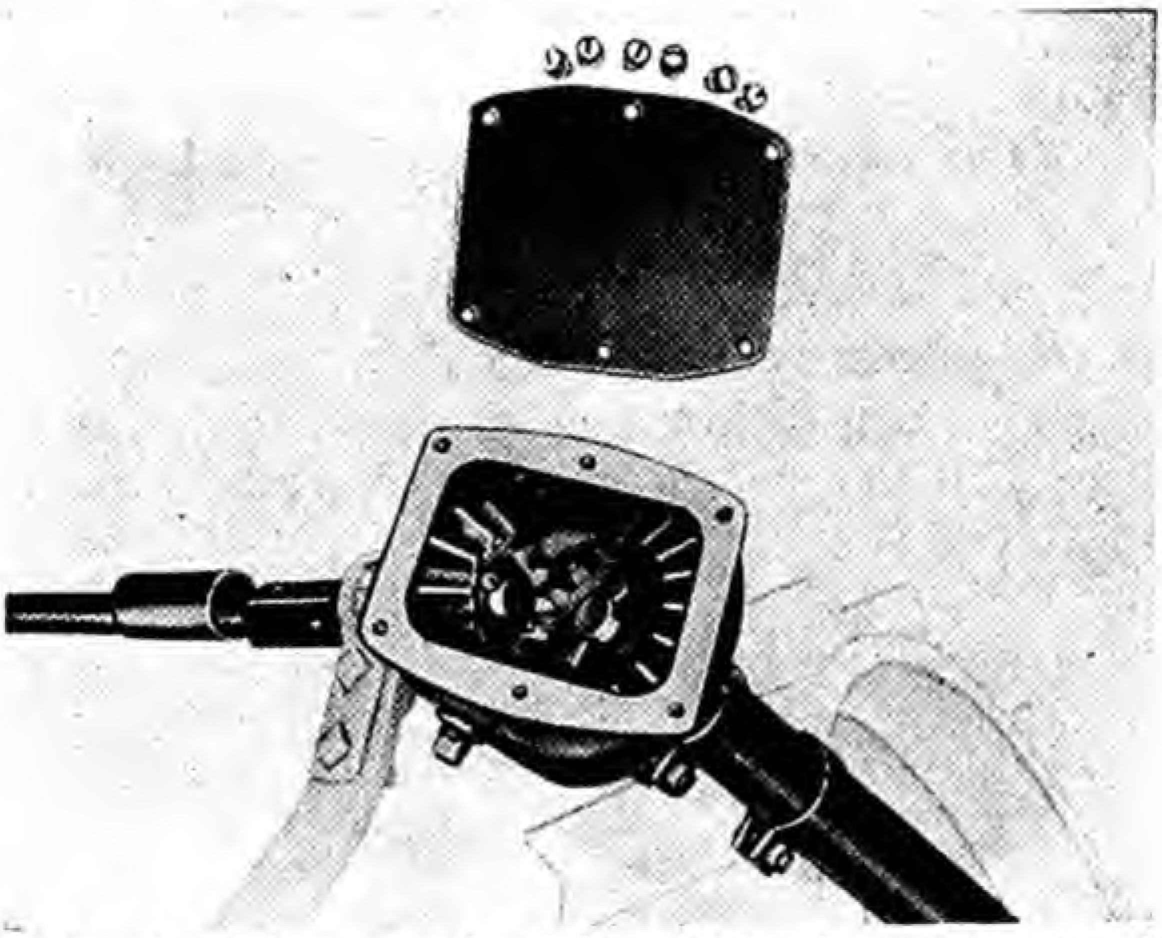


FIG. 238.—Drive for the rod on a rod weeder. Note the gear for reversing direction of rotation and the universal joint.

Some farmers have substituted a sharp heavy blade for the rod. The blade, fastened to middlebreaker beams, may be 8 to 10 feet in length. It is also provided with an angling device for suction and penetration.

PART V

SEEDING MACHINERY

CHAPTER XVI

ROW-CROP PLANTERS

Planters designed and constructed to plant seeds in rows far enough apart to permit cultivation of the crop are termed *row-crop planters.* Many row-crop planters are designed to plant seeds of only one certain crop, while others may be adapted to plant more than one crop by simply changing the type of plate in the hopper. Generally, row-crop planters may be divided into five classes, named according to the kind of crop the planter is especially designed to plant. The classes are corn, cotton, beet and bean, potato, and vegetable.

Equipment for placing growing plants in the soil is called a *transplanter.*

CORN PLANTERS

Corn planters are used in every state of the United States, the southern provinces of Canada, and in all countries where corn is produced in sizable quantities. In the United States they are used most extensively in the Corn Belt of the north Middle West region. The many types of corn planters may be listed as follows:

- Horse-drawn:
  - One-row walking.
  - Two-row riding.
    - Drill.
    - Check-row.
- Tractor:
  - Two-row trailing.
  - Four-row trailing.
  - Two-row front-mounted.
  - Two-row rear-mounted lister.

Corn planters also may be classified according to the manner in which the seed are dropped, *drill* and *check-row*. *Lister planters* are drill planters designed to plant corn in listed furrows.

Horse-drawn Corn Planters

The increase in the number of tractors on farms has brought about a corresponding decrease in the number of horses and mules used on farms. Consequently, the importance of horse-drawn equipment such as corn planters has declined. However, there are still sections where the one- and two-row horse-drawn planters are used, and this justifies a brief description of these types.

234. One-row Walking Corn Drills.—One-row walking planters are described in the section on Cotton Planters. The principal difference in the walking corn drill planter and the walking cotton planter is in the size of the seed hopper and the plate equipment.

235. Two-row Riding Drill Planters.—Drill planters usually drop one kernel of corn at a time. These kernels may be spaced from 4½ inches

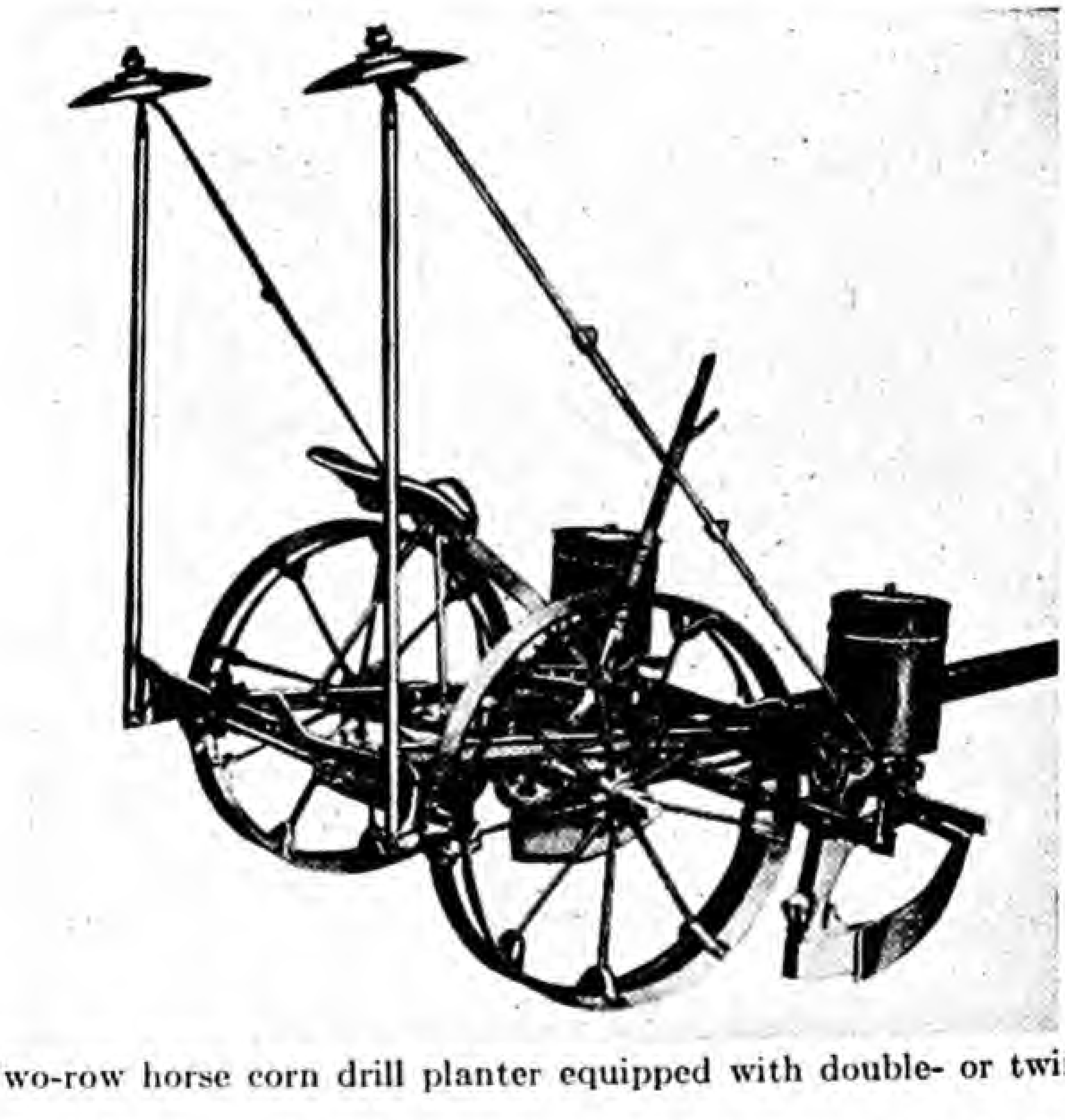


Fig. 239.—Two-row horse corn drill planter equipped with double- or twin-disk marker.

to more than 2 feet apart. The distance between kernels depends upon the number of cells in the plate and the speed at which the plate revolves. The two-row horse-drawn corn drill (Fig. 239) is simple in construction and is built in the same style as the check-row. The drill planter, however, is not equipped with the parts needed for checking.

There is some tendency toward the increased use of drill planters for corn, because when corn is harvested with the mechanical corn picker drilled corn gives a more even flow of corn through the picker mechanism

and there are no distinct shocks to the picker, as is the case when harvesting hills of corn spaced 38 to 42 inches apart.

236. Two-row Riding Check-row Planters.—Check-row planters usually drop about three kernels of corn per hill. By the use of a check

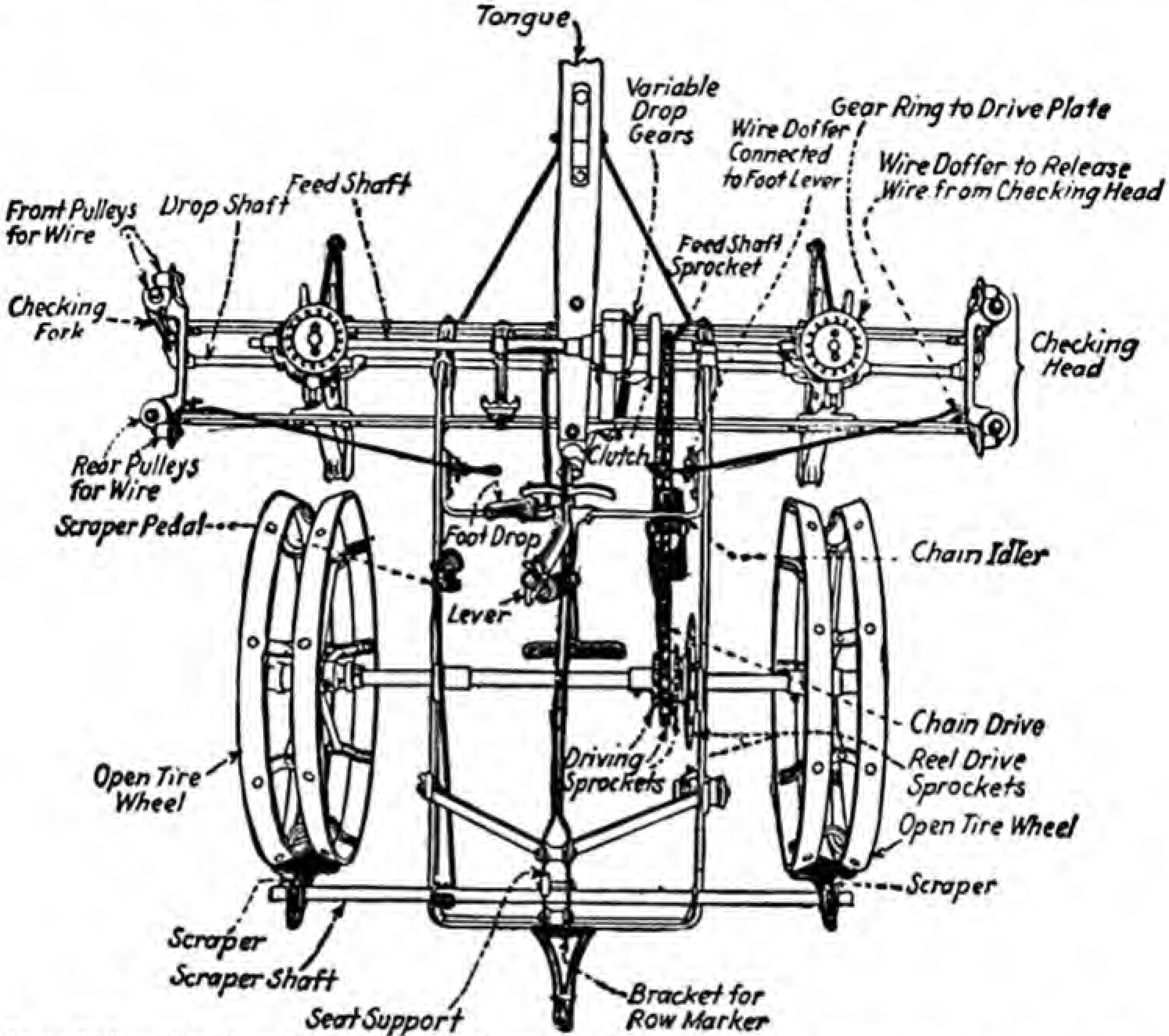


Fig. 240.—Overhead view of check-row planter with the various parts named.

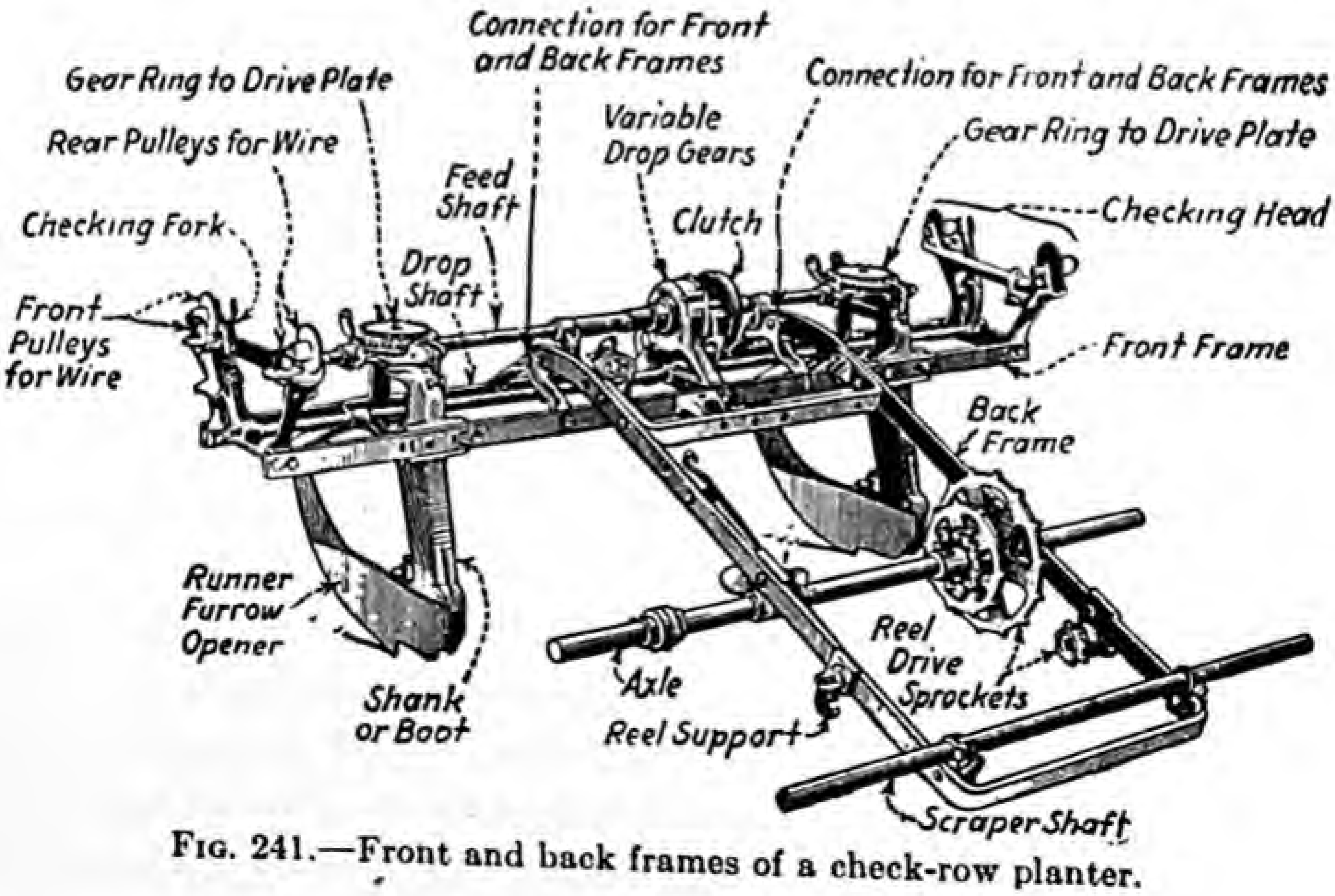
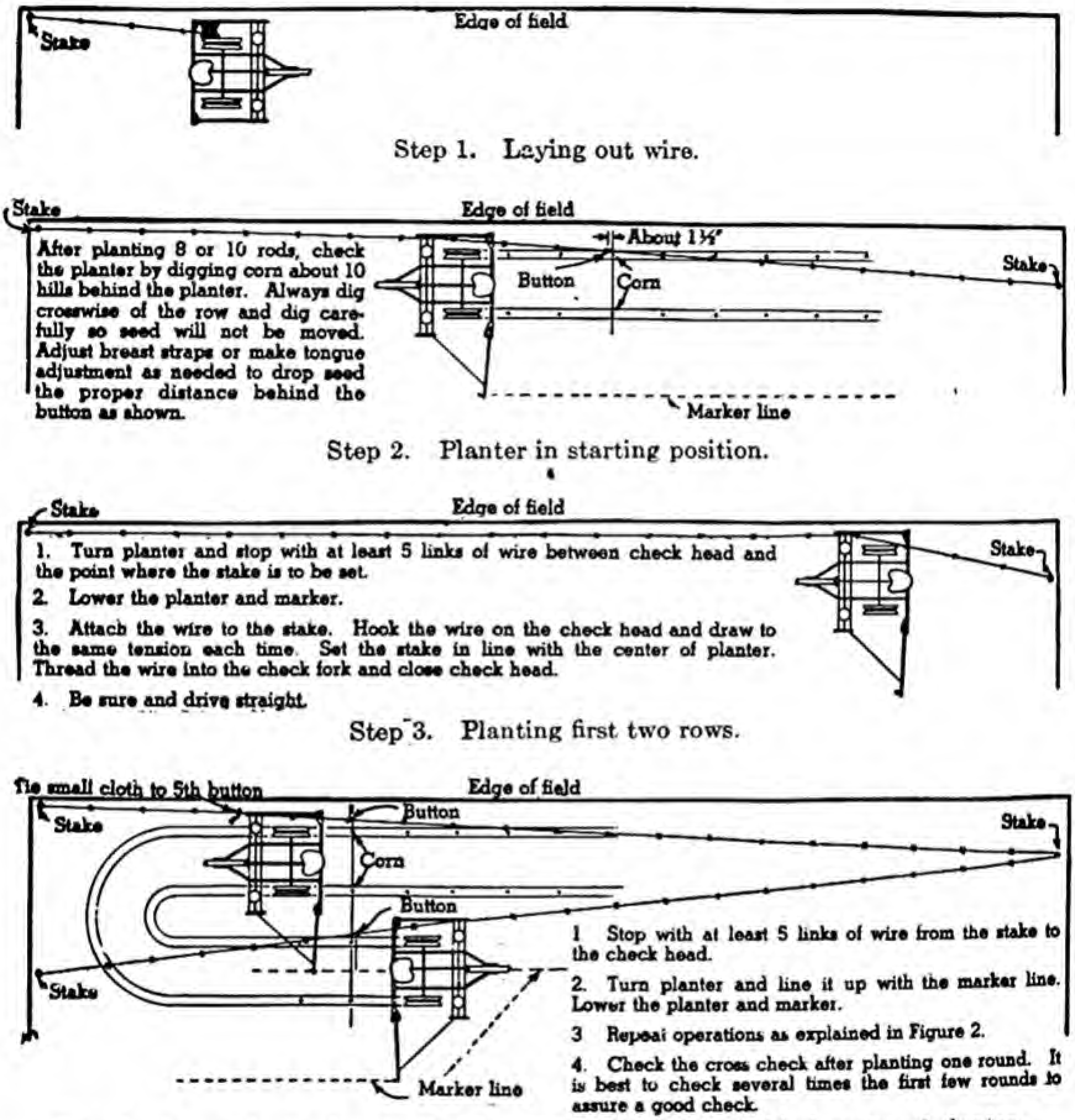


Fig. 241.—Front and back frames of a check-row planter.

wire the hills are arranged in checks or squares so that cultivation can be made both with the rows and across the rows. When the valves on the check-row planter are locked open the planter can be used as a drill. The component parts that are needed for the proper functioning of a



Step 1. Laying out wire.

Step 2. Planter in starting position.

Step 3. Planting first two rows.

Step 4. Turn planter for second two rows and set stake behind center of planter.

FIG. 242.—Steps in laying out and handling check wire, and operation of horse check-row planter.

horse-drawn check-row planter are the wheels, frame, feed shaft, clutch, plates, valves, and check wire (Figs. 240 and 241).

The sequence of operations for the various parts of a horse-drawn check-row planter is as follows: Traction power is furnished by only one of the wheels. The wheel turns the axle from which the power is transmitted to the feed shaft by sprockets and chains. The sprocket on the feed shaft works in conjunction with a clutch which permits the feed

shaft to be revolved intermittently to revolve the seed plates sufficiently to collect two or three kernels of corn on the top valve of the boot. As the planter moves forward across the field, buttons on a wire trip the top and bottom valves located in the boot, thus dropping the kernels of corn into the soil.

237. Laying Out and Handling of Check Wire.—A close study of the steps shown in Fig. 242 together with the explanations given should enable the student to understand how the check wire is laid out and handled at each side of the field.

Tractor Corn Planters

Tractor corn planters can be generally divided into two classes, *trailing* and *mounted*. Tractor-trailing planters may be further subdivided into *two-row* and *four-row*. There are also two types of mounted planters, named according to their position on the tractor. They are *front-mounted* and *rear-mounted*.

Most tractor corn planters are of the check-row type but, by locking the valves and dispensing with the check wire, these same planters can be used for the drilling of corn, soybeans, and other seeds.

Most tractor planters can be operated at speeds up to 5 m.p.h.

238. Two-row Trailing Corn Planter.—The two-row tractor-trailing check-row corn planter has many features of the horse-drawn check-row

Fig. 243.—Two-row check-row tractor corn planter equipped with fertilizer attachments.

planter. The frame and hitch are made of heavier steel. The planter shown in Fig. 243 is mounted on rubber-tired wheels. Small open-center wheels serve as press wheels.

239. Four-row Trailing Corn Planters.—Some four-row trailing-tractor check-row corn planters appear to be two regular two-row planters attached together with a suitable tractor hitch. Check heads are provided only on the outer sides (Fig. 244). The planters may have large open-center wheels or small wheels of the same type. The four-

FIG. 244.—Four-row trailing check-row tractor-operated corn planter.

FIG. 245.—Four-row check-row tractor-drawn corn planter.

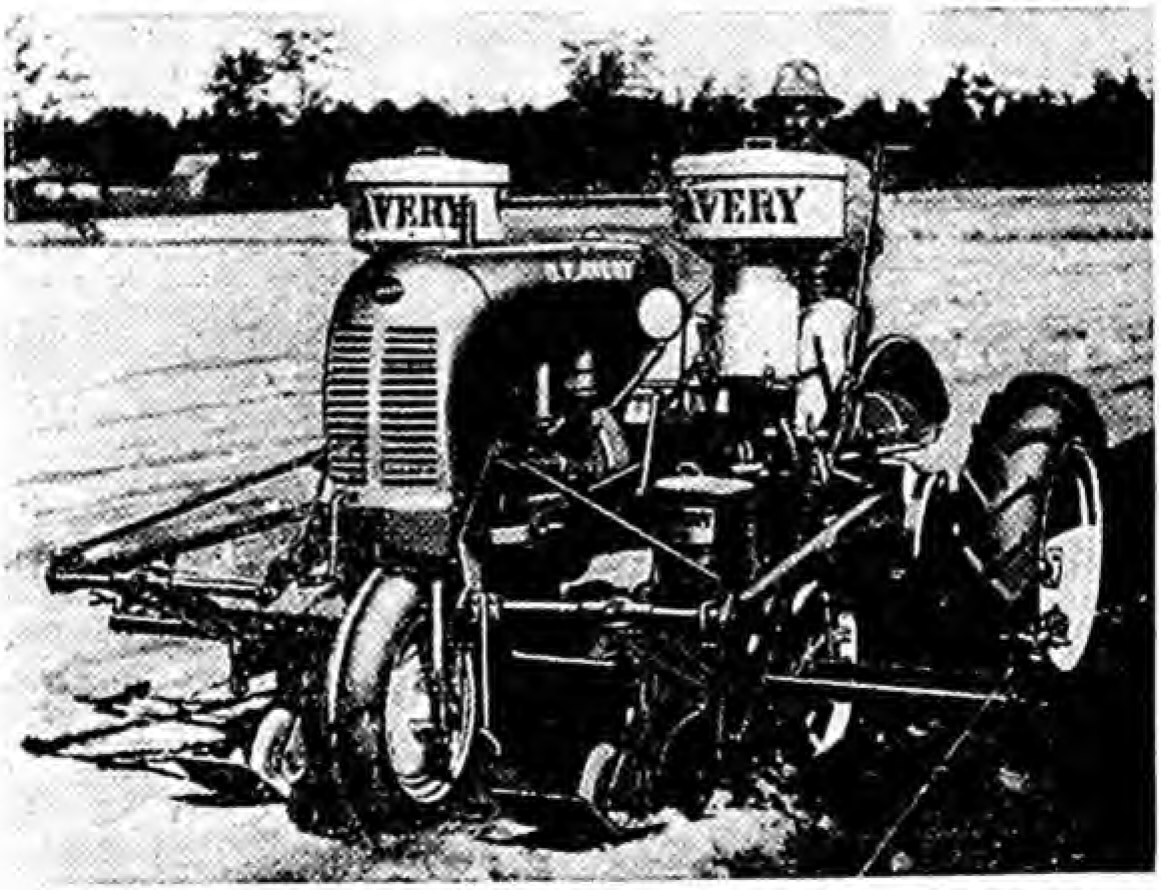


FIG. 246.—Front-mounted tractor check-row planter.

row planter shown in Fig. 245 is provided with rubber-tired wheels to carry most of the weight of the planter while planting and all the weight while turning.

240. Two-row Front-mounted Corn Planter.—The planter shown in Fig. 246 is mounted in front of the operator and integral with the tractor.

With the planter in front, the operator is able to watch its operation without having to turn his head.

241. Corn Seed Plates.—Four types of seed plates are used for planting corn, namely, the edge-drop and the flat-drop, which have the

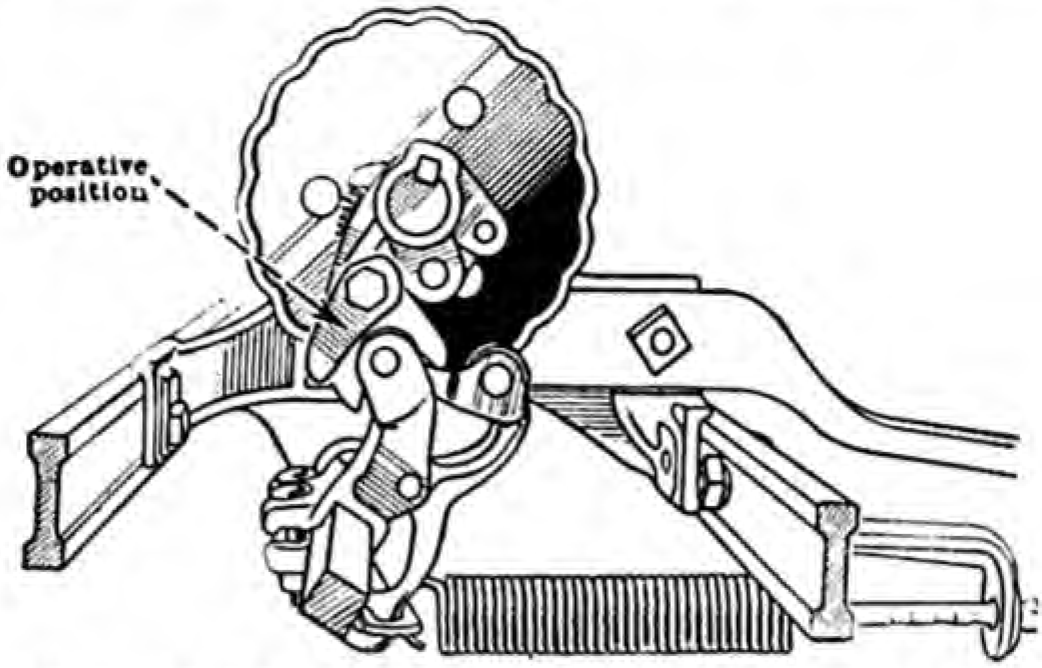


FIG. 247.—Clutch on check-row planter in engaged position.

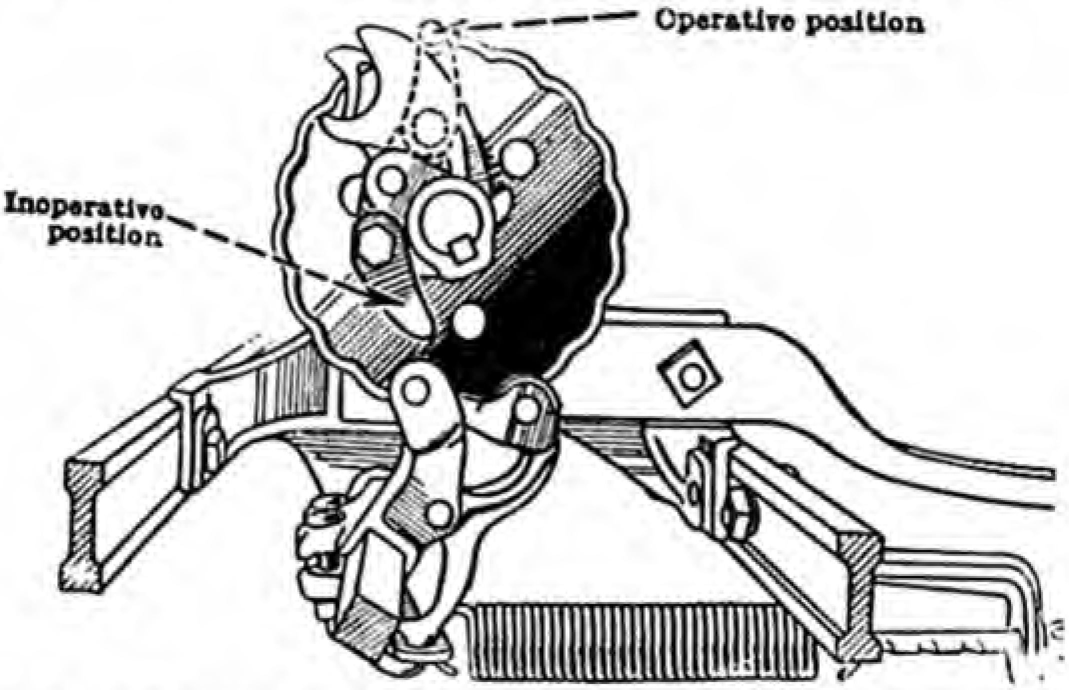


FIG. 248.—Clutch on check-row planter in disengaged position.

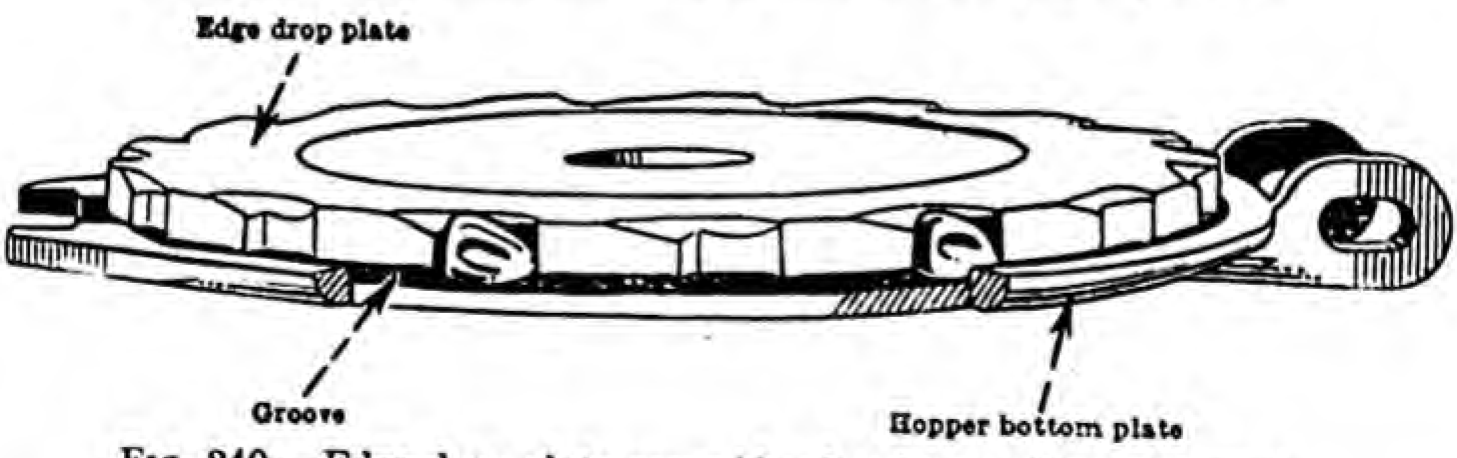


FIG. 249.—Edge-drop plate assembly showing position of kernel.

cells around the outer edge of the seed plate; the flat-drop round-hole type; and the *full-hill* plate. The *edge-drop* (Fig. 249) carries the kernel of corn on edge in the cell of the plate. The *flat-drop* (Fig. 250) carries the kernel flat in the cell of the plate. Only one kernel of corn is selected in each cell at a time. As the plate revolves, the kernels are dropped

upon the top valve until the desired number of kernels have been accumulated; then the valve is opened and they are dropped upon the lower valve and next into the soil.

The *full-hill plate* (Fig. 251) has cells around the outer edge large enough to admit several kernels at the same time. Sufficient kernels for

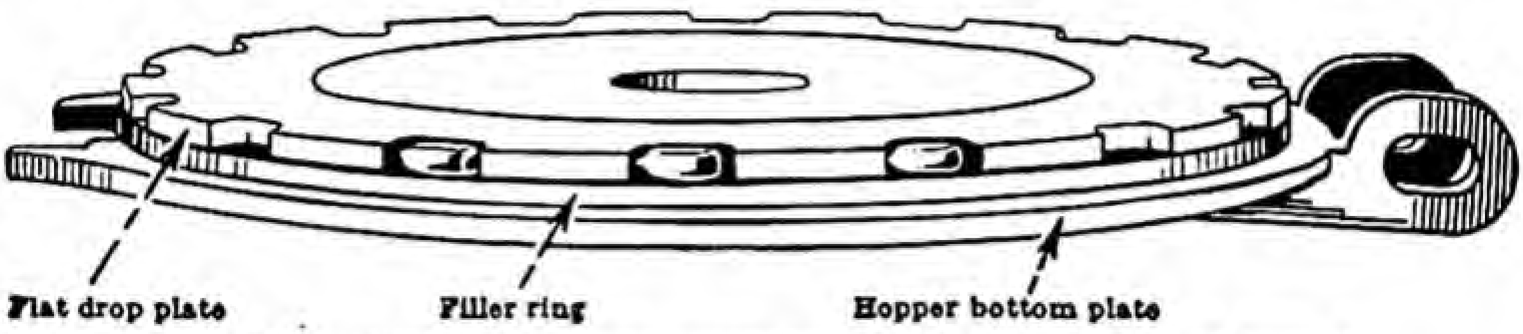


FIG. 250.—Flat-drop plate assembly showing position of kernel.

one complete hill are dropped upon the valve without having to be accumulated.

The *flat-drop round-hole* type of plate (Fig. 253) is not used on check-row planters but is used on many drill planters.

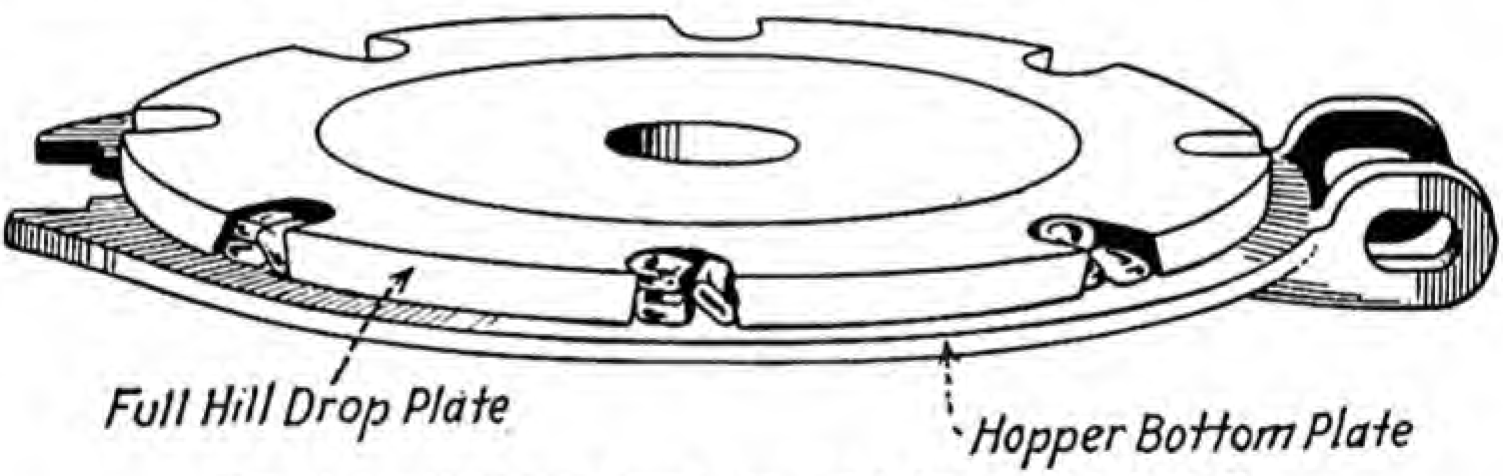


FIG. 251.—Full-hill drop plate with kernels in the cells.

Kernels of corn do not vary greatly in thickness. They do, however, vary considerably in length. It is essential to select a plate having cells of sufficient thickness to prevent cracking the kernels as they pass under the cut-off cover plate. Where the kernels are selected to lie flat in the

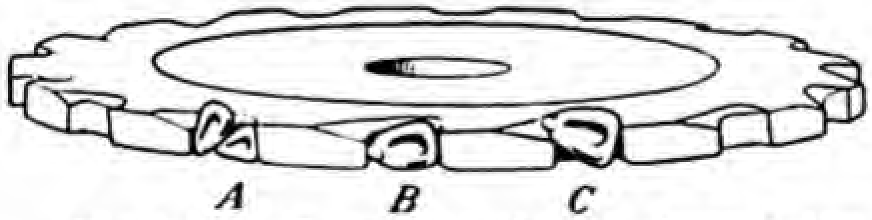


FIG. 252.—Edge-drop showing kernels too small for cell at *A* and too large for cell at *C*. Kernel at *B* is correct size for cell.

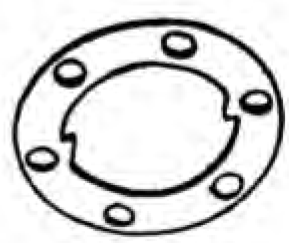


FIG. 253.—Corn plate with round-hole cells.

cell, several plates are furnished, with cells adapted to small, medium, and large kernels. Both the edge-drop and the flat-drop plates do satisfactory work provided the size of the cell suits the size of the kernel. In each type the corn should be graded to a uniform size. This is more important in the edge-drop than in the flat-drop.

The extensive use of high-priced hybrid corn seed and the many different grades of seed corn make the selection of the proper plate for a particular size and shape of graded kernel a difficult task. One manufacturer is attempting to standardize on a sixteen-cell plate. Plates with different-sized cells will be available. The rate, or pounds of seed planted per acre, is varied by changing the speed of the plate.

242. Selecting and Dropping of Seed.—The accuracy of a planter depends upon the uniformity of kernels, shape of hopper bottom, speed of the plate, shape and size of the cells, and fullness of the hopper.

A crowned hopper bottom (Fig. 254) causes the seed to gravitate into the cells. Frequently more than one kernel is partially in the cell.

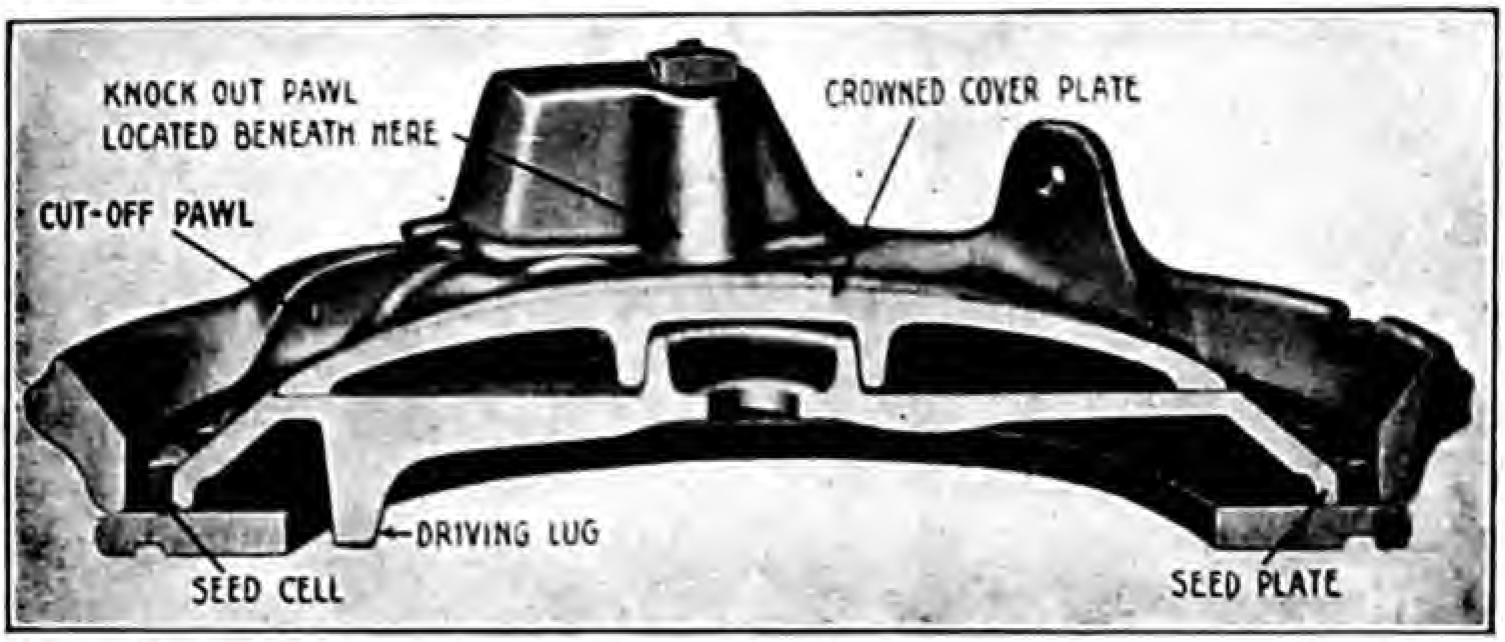


FIG. 254.—Cross section of hopper bottom, plate, and cover showing cells and cut-off pawl.

The yielding *cut-off* pawl (Fig. 254) acting under spring pressure pushes the extra kernels back as the cell passes under the plate cover or it cuts them off from the cell and, at the same time, presses the kernel firmly into the cell.

As the plate revolves to where the cell is over the seed tube, a yielding *knock-out* pawl under spring pressure comes in contact with the kernel, knocking it through the cell into the seed tube, where it is allowed to fall either upon the valve, if checking, or directly into the soil, if drilling.

243. The Variable Drop.—All check-row planters are provided with devices to vary the speed of the plate and change the number of kernels in the hills.

The most common method consists of a set of three gear changes mounted upon the feed shaft. The gears are enclosed in an oiltight case, and the change in the number of kernels is made by shifting a conveniently located lever.

244. Valves.—Most check-row planters have two valves in the boot or shank. One of these is located at the top of the boot just under the seed plate, while the other is at the bottom of the boot and in the rear part of the furrow opener. The two valves open and close at the same

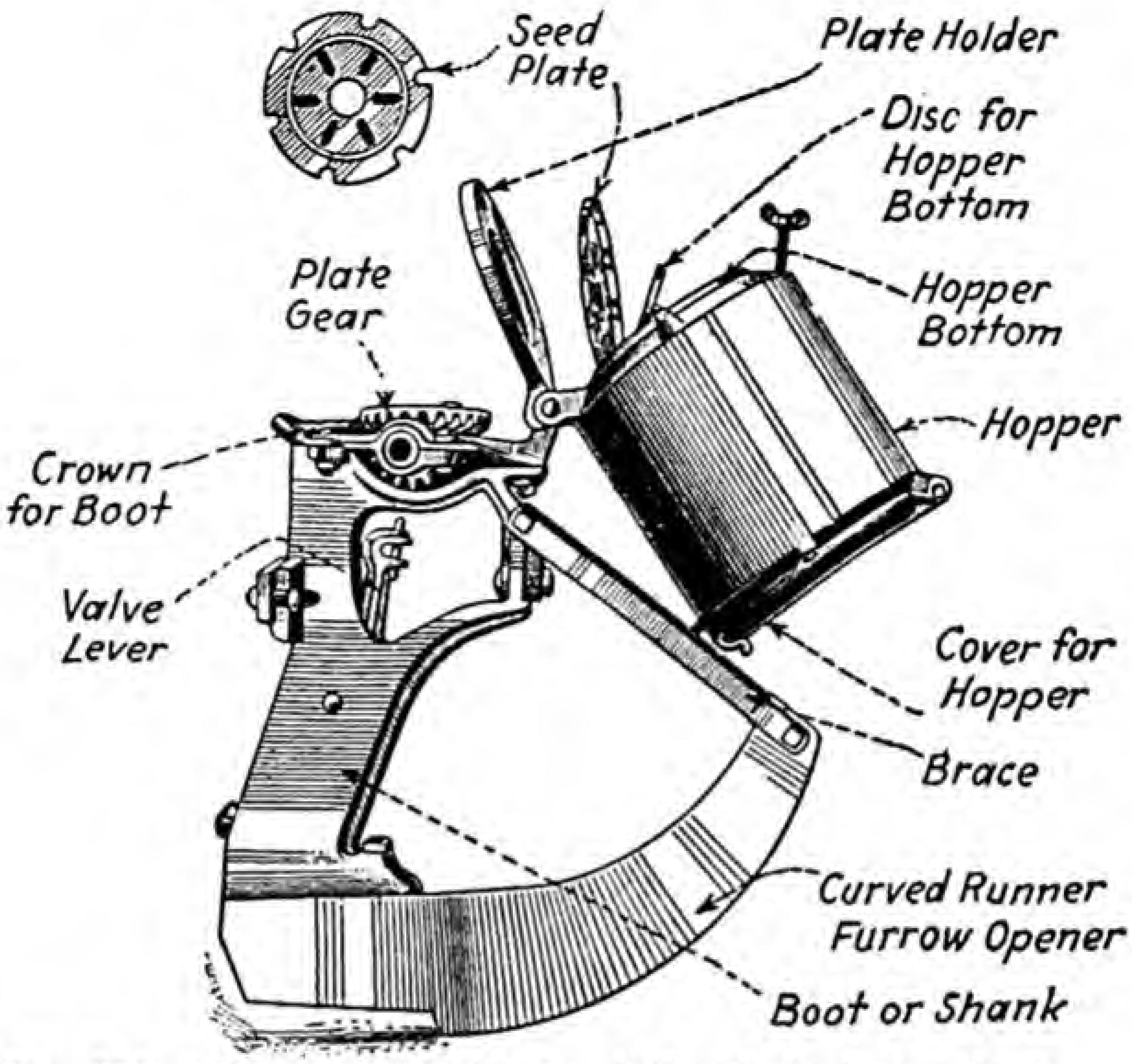


FIG. 255.—Planting assembly for drill and check-row planters.

time. Kernels of corn accumulated on the top valve, while closed, are dropped and caught by the lower valve when the buttons on the wire trip the check fork and open both valves. Springs close the valves so quickly that the kernels do not have time to pass from the top valve into the soil before the lower valve closes.

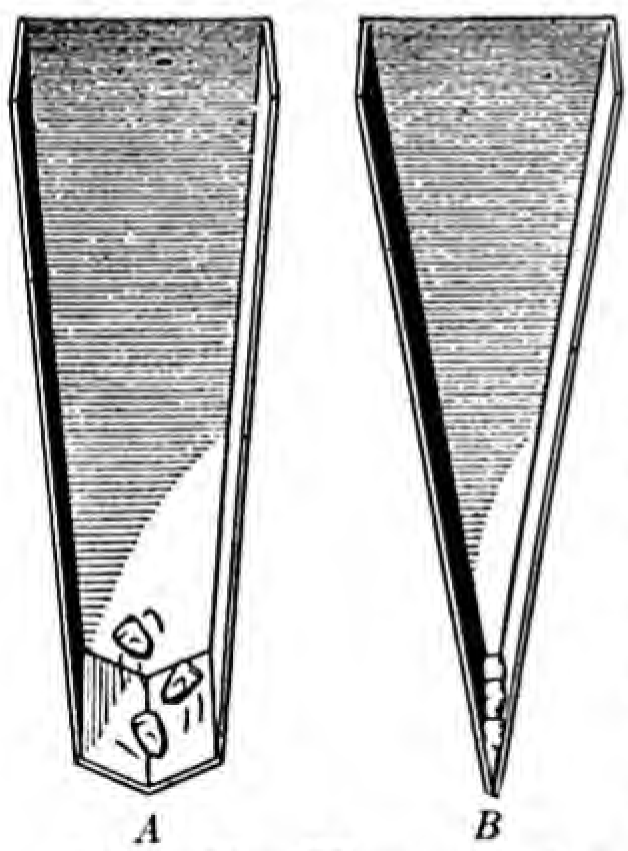


FIG. 256.—When planting at high speed the valves open and close rapidly. To prevent bouncing as in *A* the valve *B* is made wedge-shaped.

The lower valve is necessary to prevent the hills being staggered and the kernels scattered. When drilling is desired, the valves can be locked open, allowing the seed to drop from the seed plate directly into the soil.

When planting at high speeds of 5 m.p.h., it was found by Sandmark[1] that the valves designed for low speeds reacted differently at high speeds. Three things affecting the dropping of the kernels in well-bunched hills were found to be (1) The kernels bounced on the flat valves; (2) they did not fall in a compact bunch; and (3) there was a tendency to kick the kernels out and scatter them.

[1] SANDMARK, A. C., Check-row Planting at Higher Speeds, *Agr. Eng.*, Vol. 25, No. 10, p. 386, 1944.

A high-speed wedge-shaped valve (Fig. 256) corrected these faults. With a V-shaped valve at the top of the boot and a smooth tube the kernels stayed bunched as they dropped from the top to the bottom valve. With a V-shaped pocket-like valve which curved forward at the bottom of the boot, the kernels in the lower valve were in contact with the ejector and were pushed out in a compact bunch.

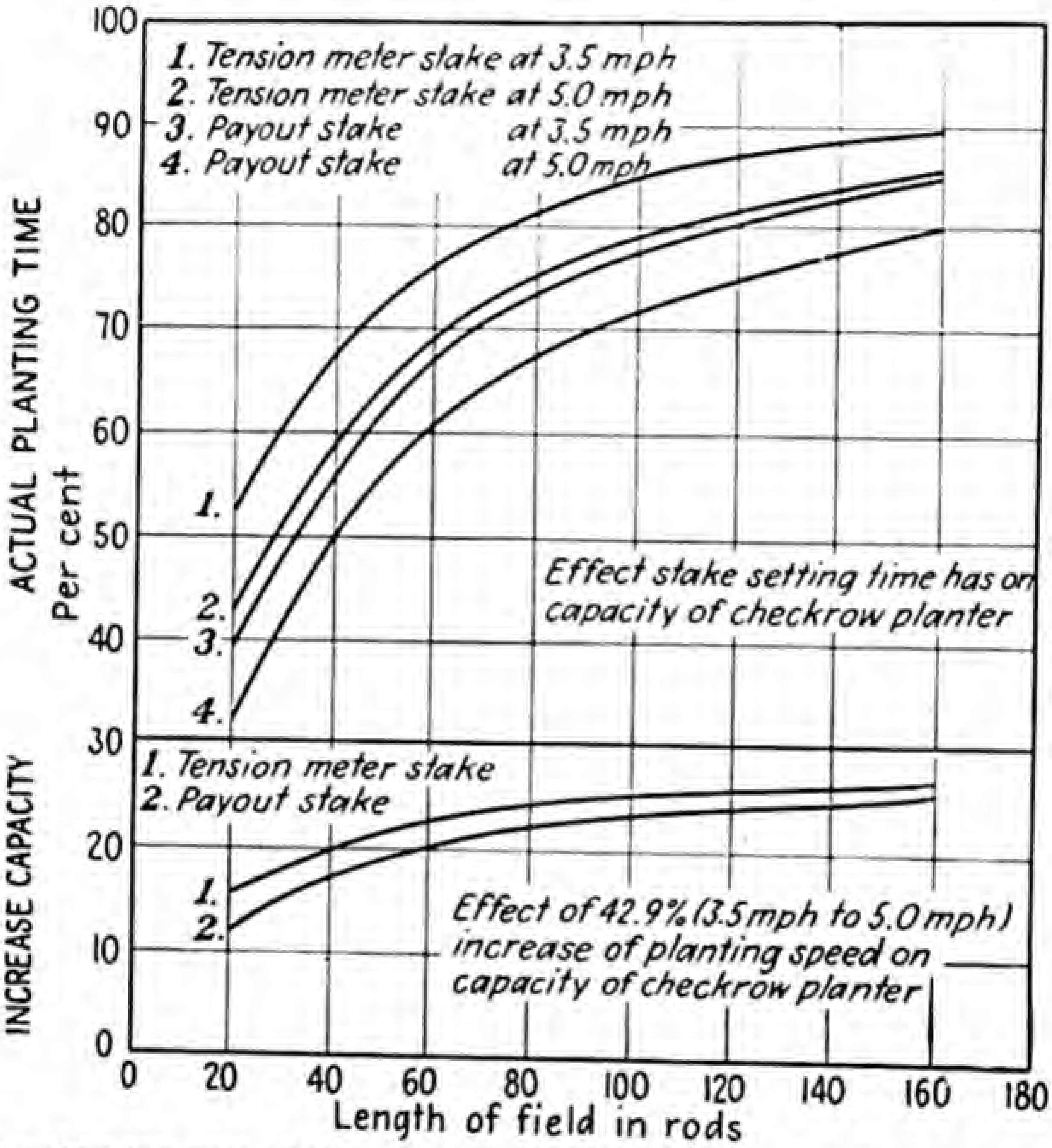


FIG. 257.—The top part of the graph shows percentage of time planter is placing seed in the soil with tension-meter and pay-out stakes when operated at 3½ and 5 m.p.h. The bottom part of the graph shows increase in planting capacity because of 42.9 per cent increase in speed from 3½ to 5 m.p.h. (*H. V. Hansen, Time and Labor-saving Possibilities of a High-speed Drill Planter, Agr. Eng., Vol.* 25, *p.* 387, 1944.)

Check-row planter valves have not been designed to operate accurately at speeds greater than 5 m.p.h. When planting at the higher speeds the wire buttons, of course, pass through the check head faster. Table XI shows the maximum number of wire buttons that should pass the planter with different spacing of the buttons.

If the planter is set to drop four kernels per hill the speed should be limited to 4 m.p.h.

It also can be pointed out that there is considerable loss of time in handling the check wire and anchor stakes when using a check-row

TABLE XI.—NUMBER OF WIRE BUTTONS PASSED PER MINUTE AT 5 M. P. H. WITH DIFFERENT BUTTON SPACINGS, USING THREE KERNELS

Button Spacing, in Inches	Buttons Passed per Minute at 5 M. p. h.
42	125
40	130
38	135
36	140
34	145
32	150
30	150

planter. Hansen[1] found that approximately half the time required to plant a field with rows 20 rods long was consumed in handling the check wire and the stakes. When the rows were 160 rods long the time required ranged from 10 to 20 per cent, depending upon the speed of operation and the type of stake used. The graph in Fig. 257 shows the effect of stake-setting time and operating speed.

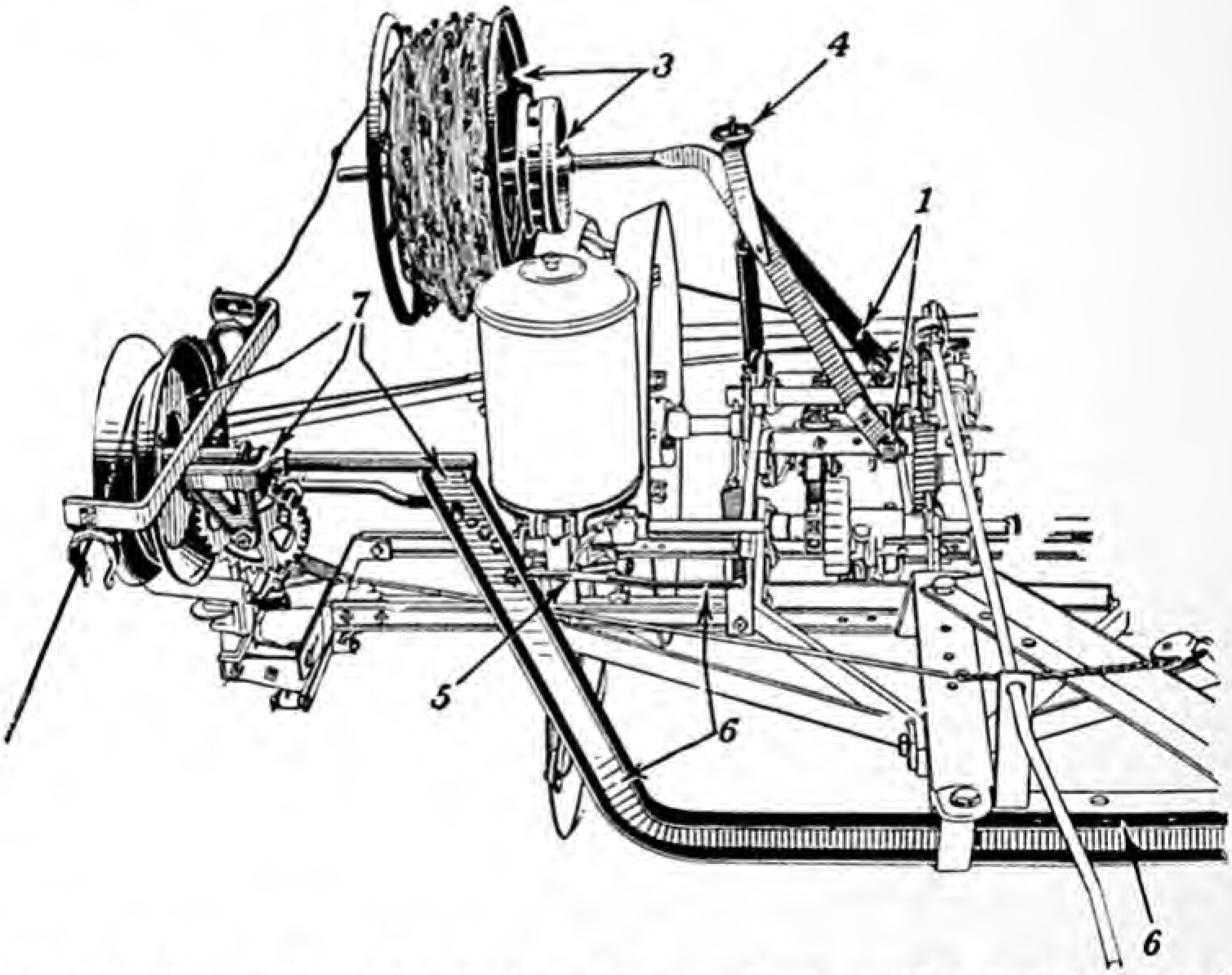


FIG. 258.—Check-row wire reel and wire-guide assembly in position for taking up wire for tractor planter.

245. Check Wire.—The check wire is usually furnished in 80-rod lengths, having buttons anywhere from 30 to 48 inches apart. Special wire with shorter spacing can be secured. At intervals of 5 or 6 rods,

[1] HANSEN, H. V., Time and Labor Saving Possibilities of a High-speed Drill Planter, *Agr. Eng.*, Vol. 24, No. 10, p. 387, 1944.

special spreading links are provided so that the wire can be disconnected and passed around obstructions such as trees.

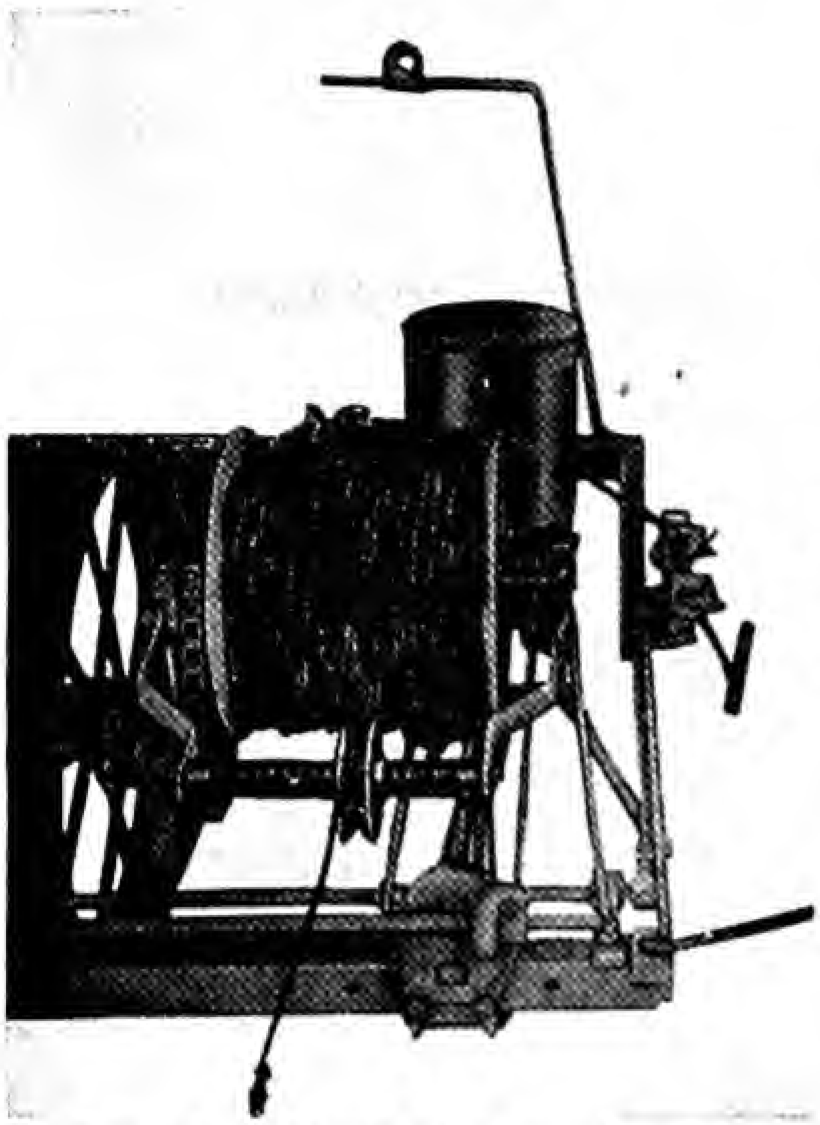
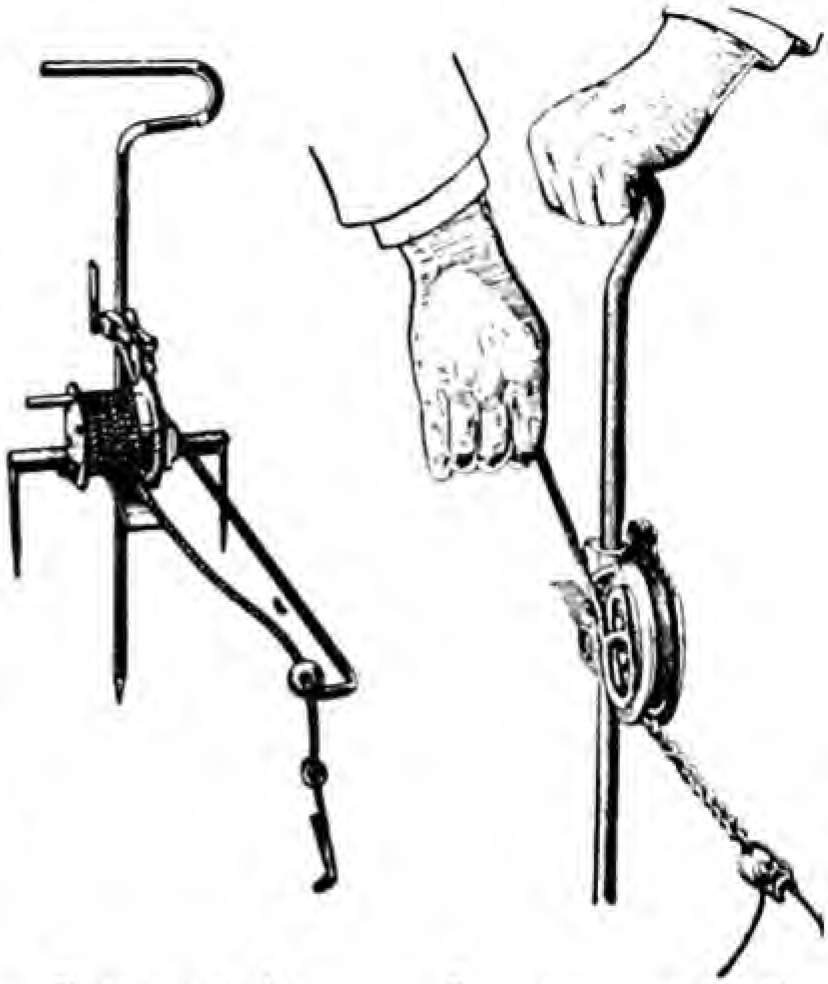


FIG. 259.—Check wire reeled up. Note the small pulley wire guide to keep the wire level on the reel as it is reeled up.



Pay-out stake Tension-meter stake

FIG. 260.—Anchor stakes used with tractor check-row planters.

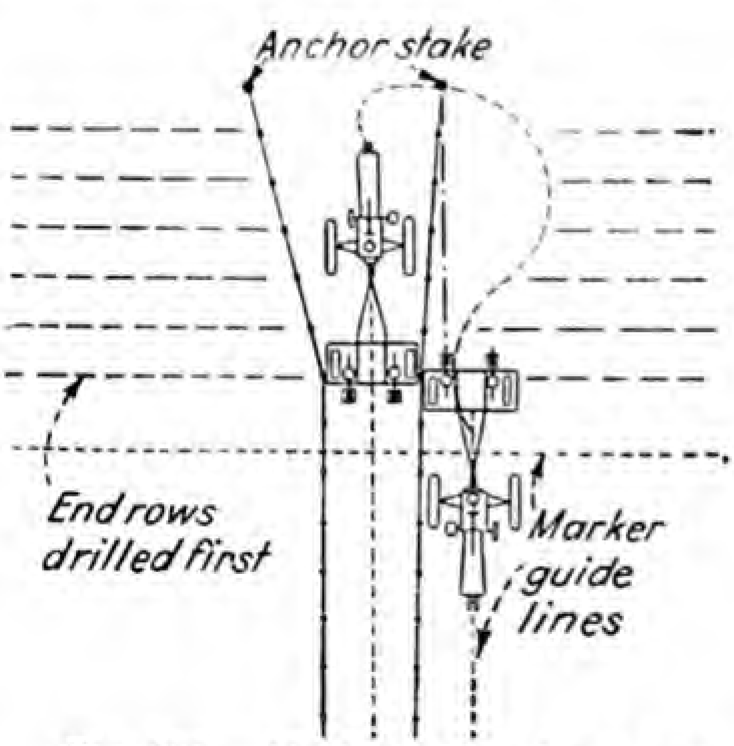


FIG. 261.—Method of turning a two-row tractor check-row planter and location of tension-meter stake on driving up to and away from the stake.

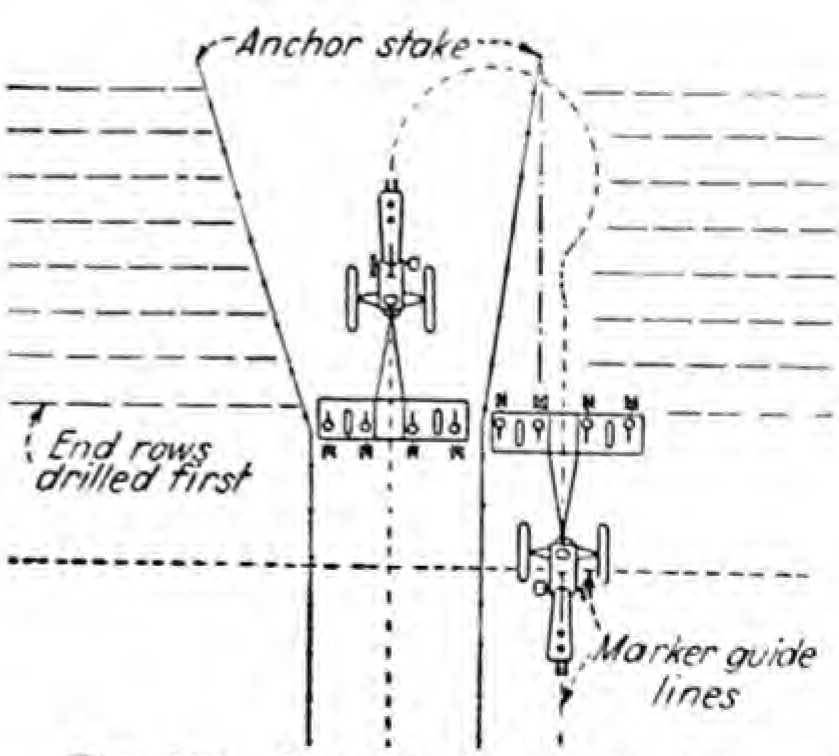


FIG. 262.—Method of turning a four-row tractor check-row planter and location of tension-meter stake on driving up to and away from the stake.

When the planter is not being used, the wire is rolled up on a reel. The reels on most check-row planters are now provided with a wire guide to keep the wire level on the reel as it is reeled up (Fig. 258). This

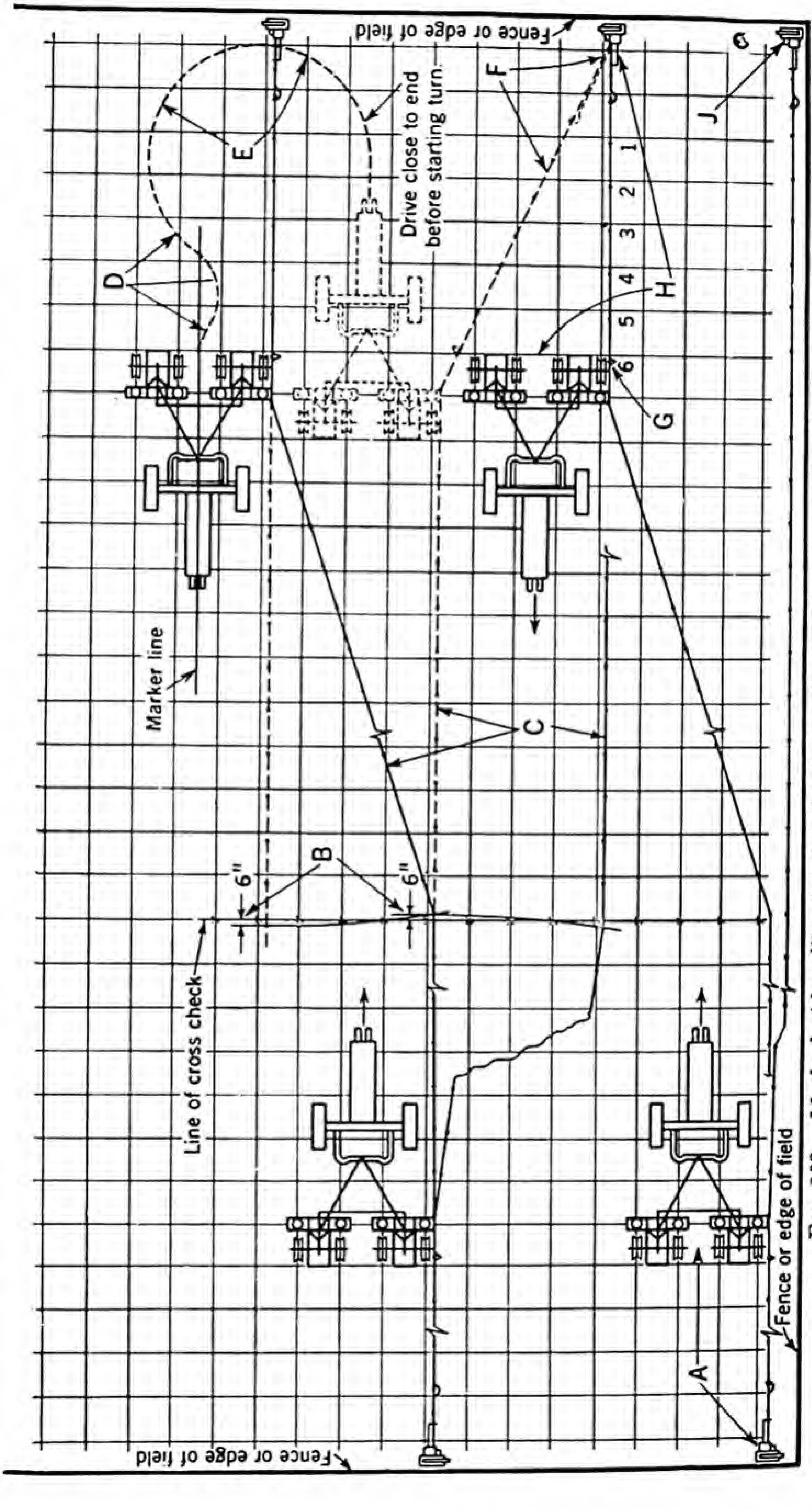


FIG. 263.—Method of handling tractor check-row planter when pay-out anchor stake is used.
(Legend continued on opposite page.)

works on the same principle as that used to wind thread on the bobbin of a sewing machine.

246. Operating Tractor Check-row Planters.—In the operation of the horse-drawn check-row planter the anchor stake is set directly behind the center of the planter. In the operation of tractor check-row planters two types of check-wire anchor stakes are used, namely, the *tension-meter* type and the *pay-out* type (Fig. 260). When using the tension-meter check-wire anchor stake with a two-row tractor planter, the stake is set directly behind the furrow opener or seed box next to the wire side of the planter (Fig. 261). When the tension-meter stake is used with a four-row tractor planter, the anchor stake is set directly behind the second furrow opener or seed box from the wire side of the planter (Fig. 262).

When using the pay-out check-wire anchor stake, it is set in line with the check head on the wire side of the planter (Fig. 263). When the planter approaches the stake and is about eight buttons from it, the angle of the wire swings the ratchet on the stake out of engagement and permits the rope on the drum to pay out, relieving the tension on the wire.

The tension meter is used to get a uniform tension on the wire each time the stake is set. An automatic wire release (Fig. 264) releases the wire when the planter approaches and is about seven buttons from the stake (Figs. 261 and 262).

A. Planter in position for checking first four rows. Stake set directly behind check head.

B. When hills of corn are dug to determine the accuracy of cross check, the hills will be located about 6 inches behind the button on check wire. The hills of corn are 6 inches behind, and not directly under, the button because of the arc through which the check wire is pulled from the previous position. The check wire naturally pivots at the check head, and pulling the wire from the old position to the new causes any button in the entire length of wire to swing through an arc that gives a difference of about 12 inches between the two positions. Planting about 6 inches behind the button in one direction and again planting about 6 inches behind the button on return trip (wire having been pulled over) will line up the hills across the field.

C. Note that the check wire remains straight in line with the planted rows behind the planter, while ahead of planter the wire angles across previously planted rows for a distance of about 29 knots ahead of planter and four rows over.

D. Continue turn, with tractor front wheel crossing marker line, until center of tractor rear axle is over marker line; then straighten out and move forward on line until check head is eight rows from end of field; then stop. Be sure planter is lined up square with rows before setting stake.

E. Do not turn so short that tractor rear wheels will catch planter-hitch angles.

F. As planter approaches the stake, the angle of the wire swings the ratchet on stake out of engagement with locking dog, permitting the rope on drum to pay out and thus relieving the excessive tension on the wire.

G. Tie a small cloth to sixth button from hook on stake rope. This allows eight rows head land.

H. Planter in position for checking succeeding round. Always set stake directly behind check head.

J. Set stake in corner of field when starting to lay out wire. The stakes are "right" and "left" and must be so placed in the field that the sidewise movement of drum will always be toward the unplanted portion of field.

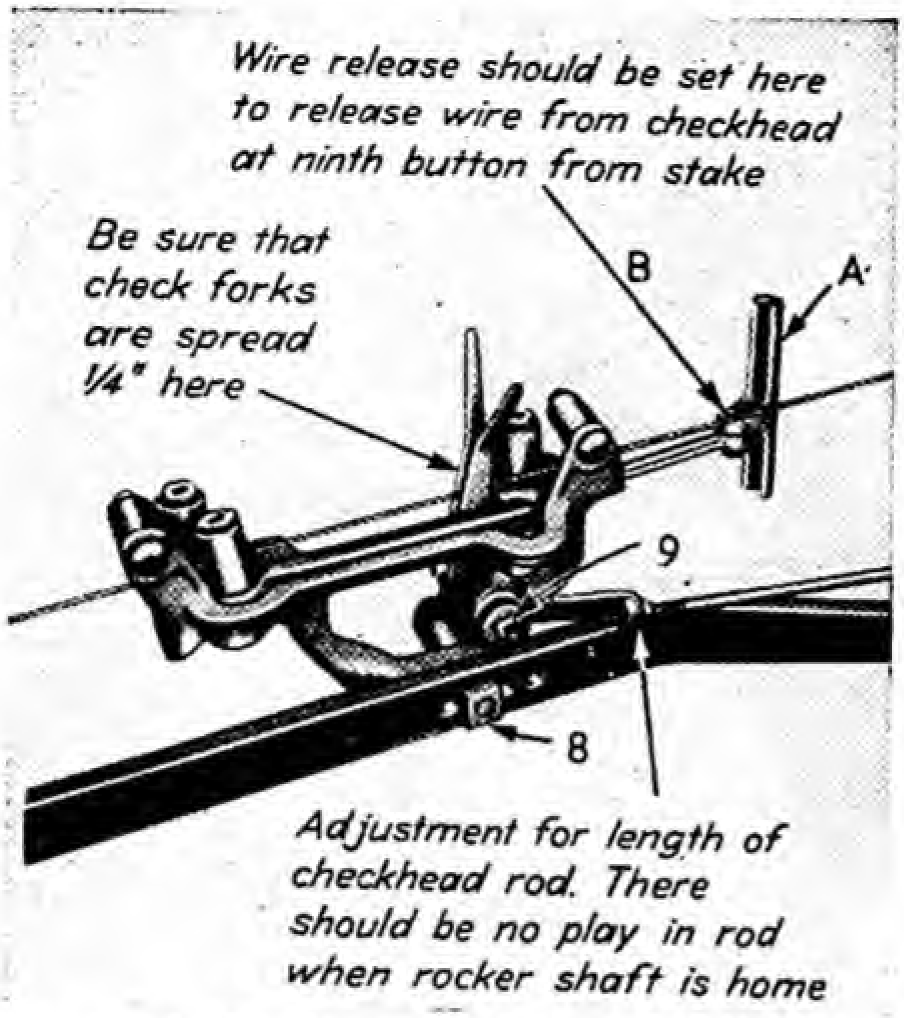
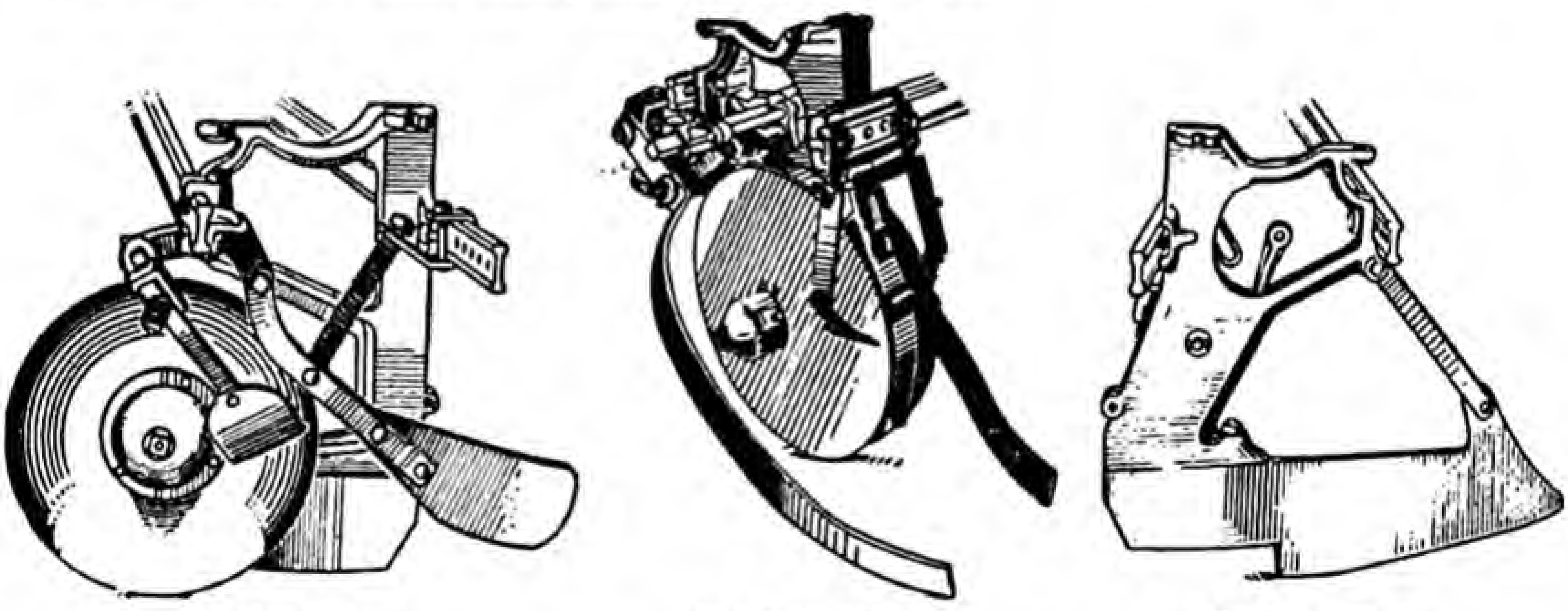


FIG. 264.—Check head, showing check fork and automatic wire release A.

247. Furrow Openers.—Furrow openers are necessary to open furrow-like trenches in the soil to receive the seed as they are dropped by the mechanism of the planter. On check-row planters four types are used: the curved runner, shown in Fig. 255; the stub runner; the single disk; and the double disk, shown in Fig. 265.



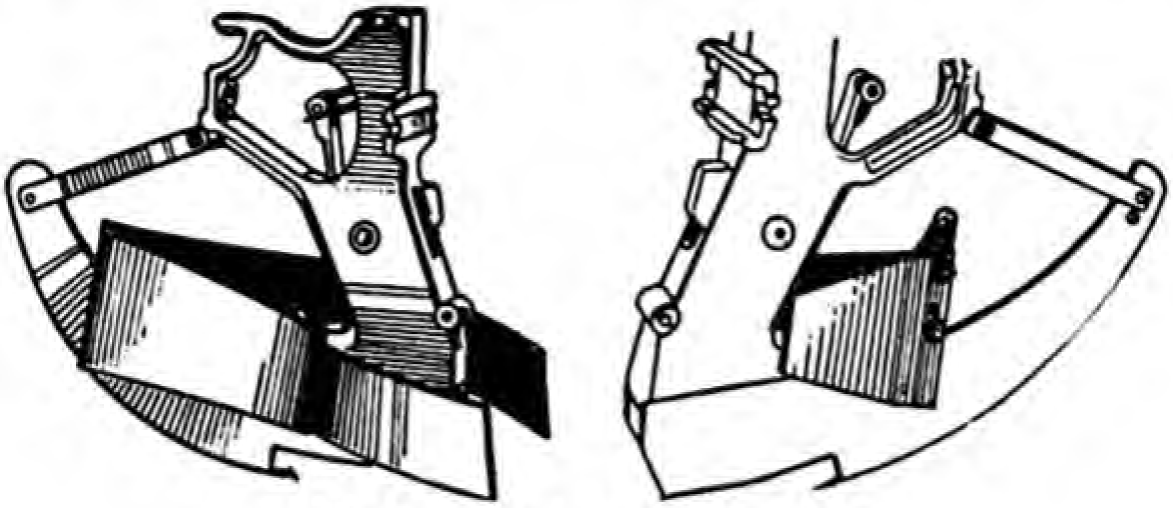
Single-disk Double-disk Stub-runner

FIG. 265.—Special furrow openers for corn planters.

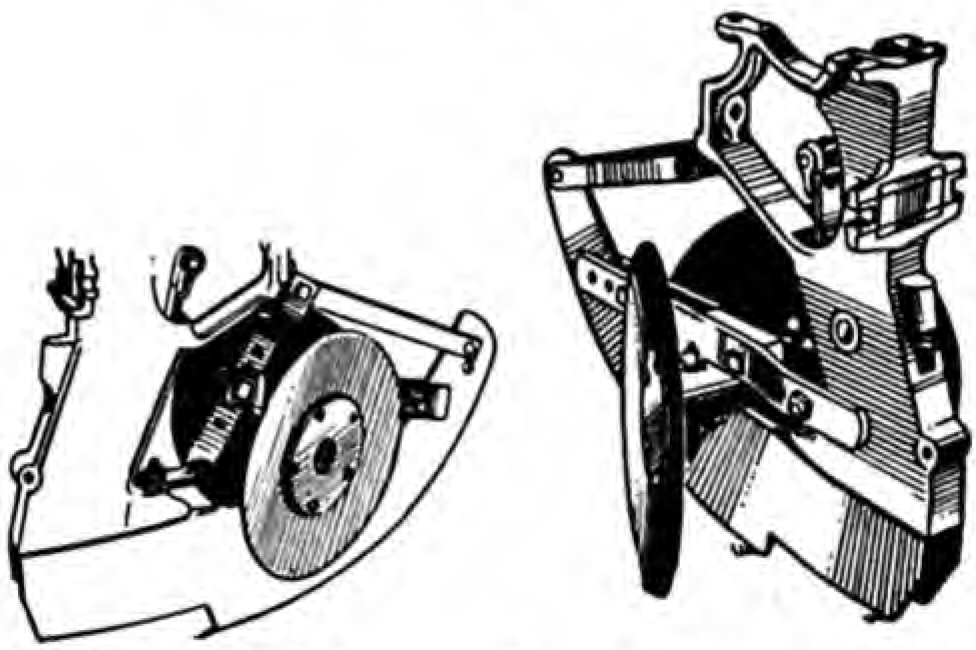
The curved-runner type of opener is in most general use. The stub runner is suited to rough and stony ground. The double-disk opener is used where a wide furrow is desired.

248. Attachments for Furrow Openers.—Various types of attachments are shown in Fig. 266. A furrowing and covering attachment is shown in Fig. 266. The first blades push away the rocks and clods, permitting the rear covering blades to scrape in a sufficient quantity of earth to cover the seed.

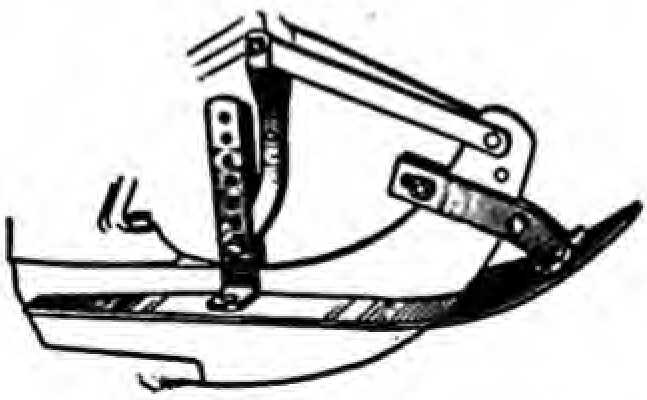
249. Row Marker.—Row markers are essential to keep the rows straight, parallel, and of equal distance apart. A disk type is shown in Fig. 239, while a shoe type is shown in Fig. 245. Double-disk markers are also used.



Blade-furrowing attachments



Nine-inch disks Eleven- to thirteen-inch disks
Disk-furrowing attachments



Gage-shoe attachment
FIG. 266.—Attachments for runner furrow openers on corn planter.

250. Special Attachments.—Several attachments are available for all types of planters. A fertilizer-distributing attachment may be mounted on any of the modern corn planters. Attachments are shown on a two-row planter in Fig. 243. The details of the types of feed and rate of distribution are discussed under Fertilizer Machinery. Some of the attachments on check-row planters, however, are provided with a valve that is operated by the check fork in unison with the valves of the

planting mechanism. Some farmers often use the regular planting mechanism to distribute fertilizer, but this cannot be done if the fertilizer is very sticky. When used in this manner, the planter should always be

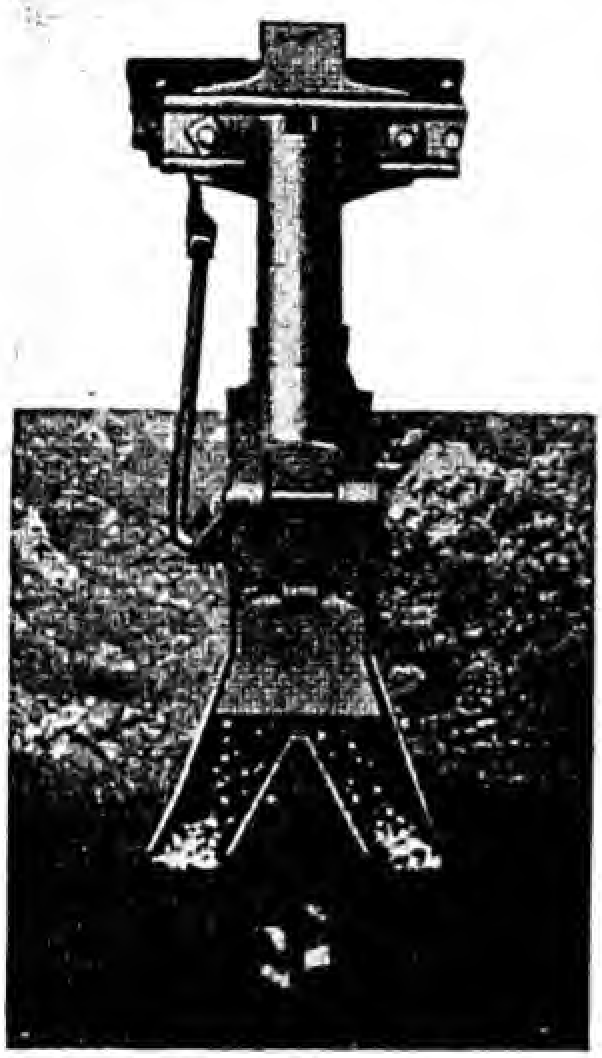


FIG. 267.—Attachment on corn planter for placing band of fertilizer on each side of the seed.

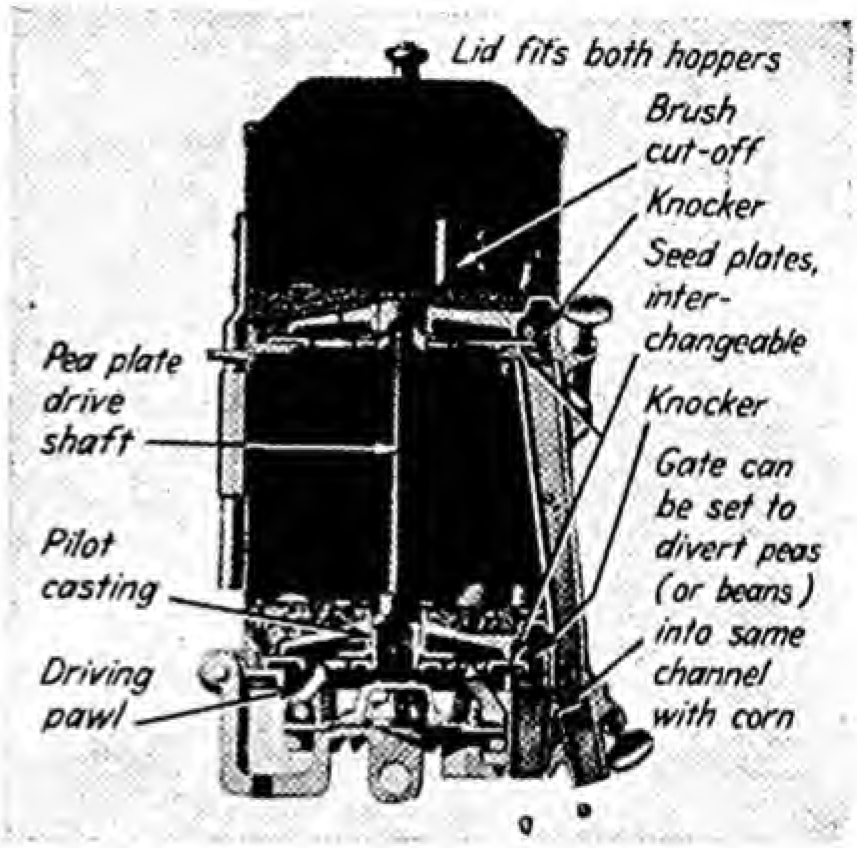


FIG. 268.—Combination corn, bean, and pea hopper.

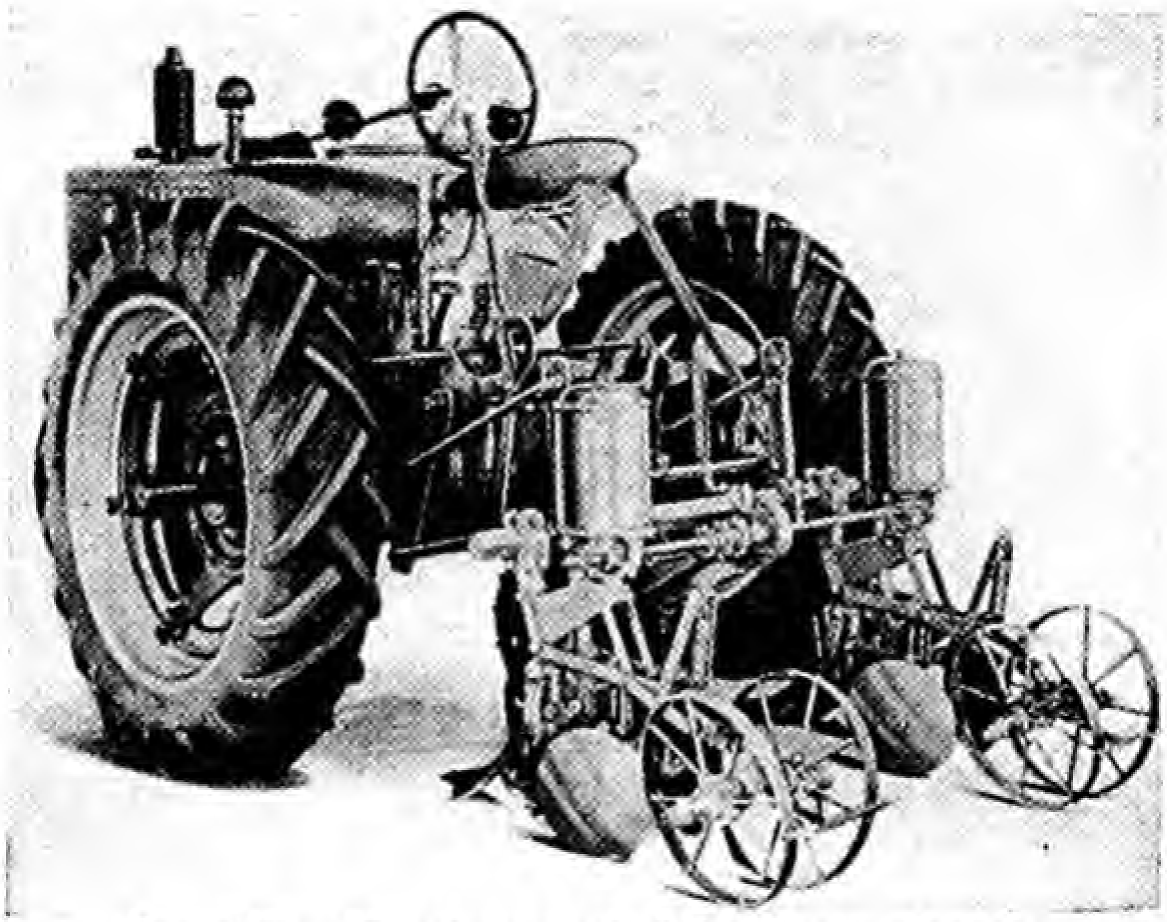


FIG. 269.—Direct-connected lister corn planter.

thoroughly washed afterward so as to prevent injury to the metal parts. Figure 268 shows a combination corn, bean, and pea hopper. Corn is placed in the lower section and other seeds in the upper section. The

seeds from the two sections can be dropped into the soil separately or together by flipping a gate valve.

251. Duty of Planters.—An average of 7.1 acres can be planted in a 10-hour day with the one-row one-horse planter when the rows are 3½ feet apart. With the same width between rows, a two-row two-horse planter will plant 14.1 acres per day.[1] A two-row check-row tractor-operated planter will plant 24 to 30 acres per day, while a four-row tractor planter will plant 50 to 70 acres per day. The length of the rows and the time spent in turning and setting the stake are influencing factors.

252. Draft of Corn Planters.—Very little is known about the draft of a corn planter. However, a two-row drill or check-row planter is considered a light load for two horses or mules. A light load for two horses may range from 200 to 300 pounds.

253. Planter Troubles.—Several common troubles are encountered in the operation of a corn planter. They are listed below with some of the causes. If the cause of the trouble can be determined the remedy is usually obvious.

1. *Inaccurate drop* may be caused by wrong seed plates, plates not put in hopper properly, cut-off or knock-out worn or out of position, poorly graded seed, valves out of adjustment, clutch slipping, and planting too fast.
2. *Poor cross check* may be caused by improper handling of wire or anchor stake, planter not square with tractor, planter not square with row when setting stake, planting too fast, planter not uniform distance from stake when setting stake, frame bent, and wire kinked.
3. *Scattering of corn in hills* may be caused by planting too fast, valves set wrong, fertilizer boots clogged or too low, check-fork prongs pinched together, worn openers, and trashy soil.
4. *Unequal depth of planting on different rows* may be caused by sprung or loose frames, opener bent, and press wheels not set the same.
5. *Jerking of planter* may be caused by bad wire buttons, parts of check head worn, wire catching on tractor wheel, and trash on wire.
6. *Missing of hills* may be caused by clutch not engaging properly and worn parts.
7. *Unequal amounts of corn on different rows* is often caused by cut-off worn or out of position, weak or broken cut-off spring, plate parts put in hopper wrong, and variable pinion set wrong.

Lister Corn Planters

Figure 269 shows a two-row, direct-connected, quick-attachable, power-lift lister corn planter. The gage wheels at the front also furnish power for driving the planting mechanism. The planter is regularly equipped with 14-inch lister bottoms, subsoiler, disk coverers, and press wheels. Shovel coverers can be used in place of the disk coverers.

[1] *U. S. Dept. Agr. Yearbook*, p. 1056, 1922.

COTTON PLANTERS

The modern cotton planter is designed so that cotton, corn, and sorghum plates are interchangeable in the same hopper. The general construction features are different from the corn planter. As a general rule cotton is planted on a ridge. However, in the subhumid areas it is planted, as other crops are, in the listed furrow.

254. Primitive Types of Cotton Planters.—The first attempts to improve upon the hand method of planting cotton was to take a cow horn, plunge it into a bag of seed, and then scatter them along the furrow. Another early ingenious arrangement consisted of a barrel or keg, making what was known as a *barrel* planter. A quantity of sand and gravel was mixed with the cottonseed in the barrel, for the purpose of preventing the seed from clinging together so they would fall through holes that had been bored at intervals around the middle of the barrel.

255. First Improved Cotton Planters.—The first great forward step in cotton-planting devices was the invention of the Dow-Law planter

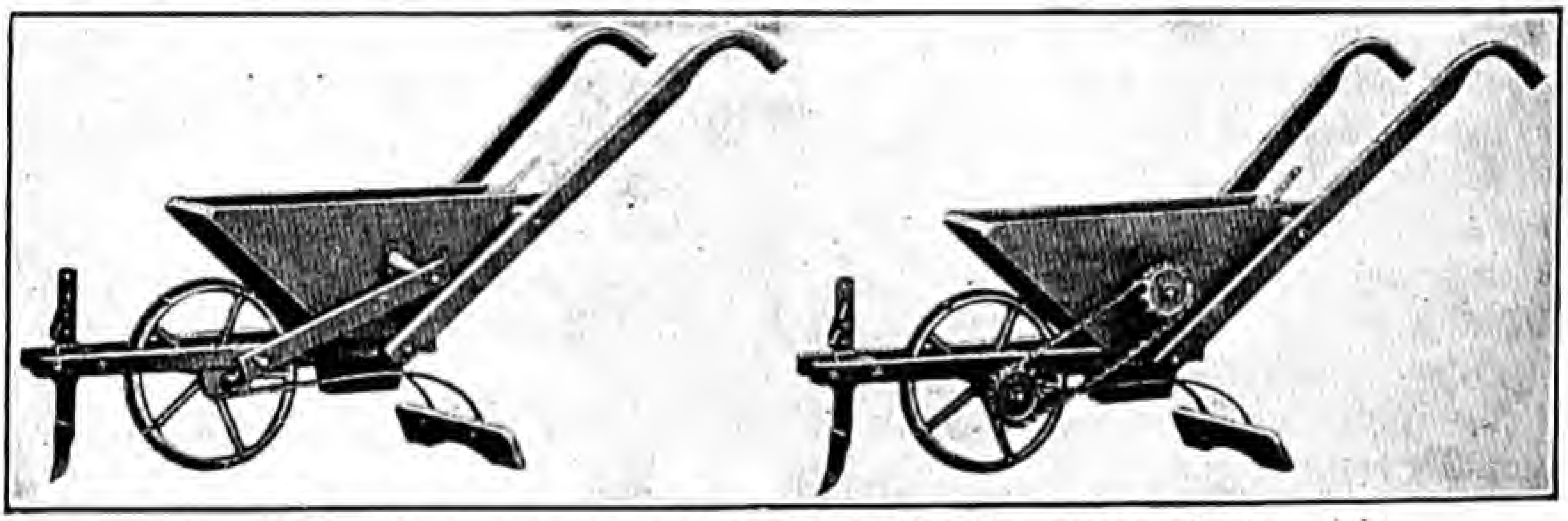


FIG. 270.—Dow-Law cotton planter, *left;* Carolina cotton planter, *right.*

(Fig. 270), about 1874. The features of this planter included a trapezoidal wooden hopper mounted on a wooden frame, at the front end of which was a steel furrow-opener blade and, just to the rear, a drive wheel. In the center, at the bottom of the hopper, was an adjustable feed gate, by which the flow of seed could be regulated.

A slight improvement over the Dow-Law planter was the "Carolina cotton planter," shown in Fig. 270. The general construction was practically the same. The principal differences were in the type of agitator and the method by which it was driven. A chain running over sprockets was substituted for a pitman, which gave a rotary instead of a reciprocating motion to the agitator.

256. Modern Types of Cotton Planters.—The modern cotton planter is really a combination type designed to plant seeds of most of the field row crops. Owing to the wide variety of conditions, there are many different types and sizes of cotton planters.

257. One-row Walking Planter.—The regular one-row walking planter is very similar to the regular corn planter in the arrangement

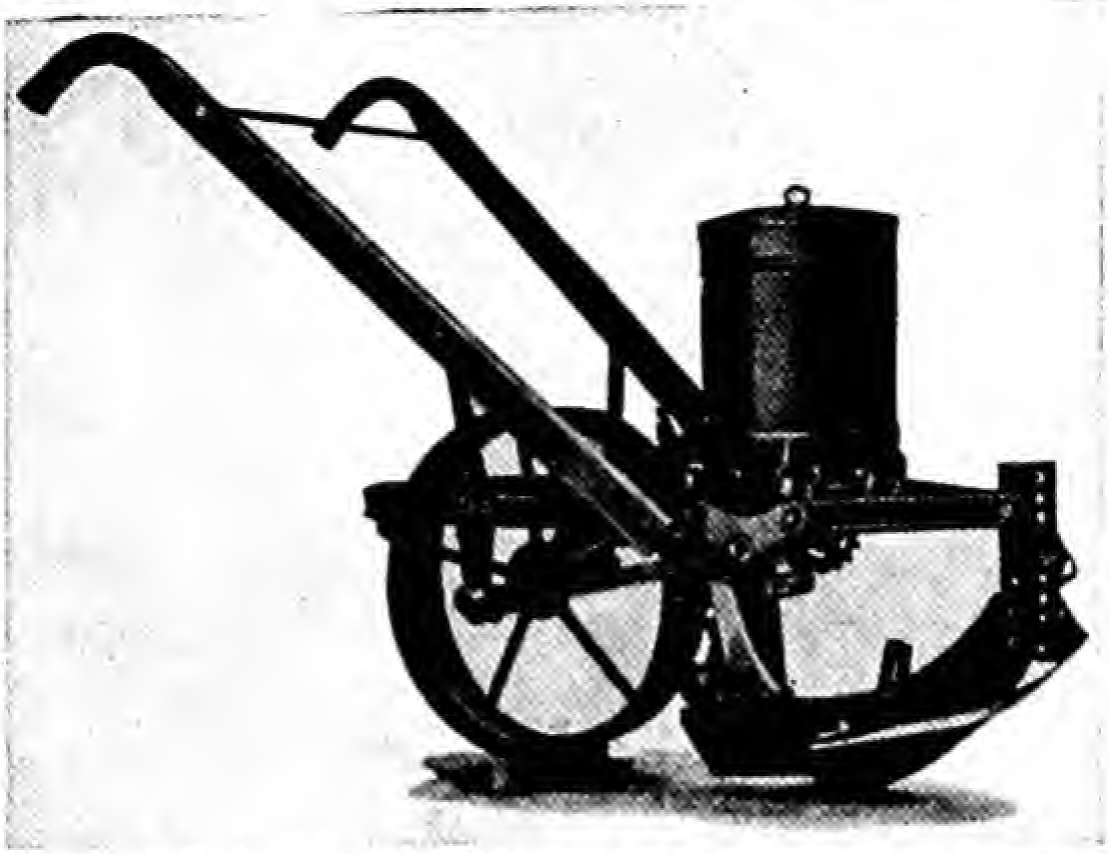


FIG. 271.—Single-row hill-drop walking planter with gage shoe on runner opener. Drive wheel in rear also serves as press wheel.

FIG 272.—Walking cotton and corn planter with fertilizer attachment.

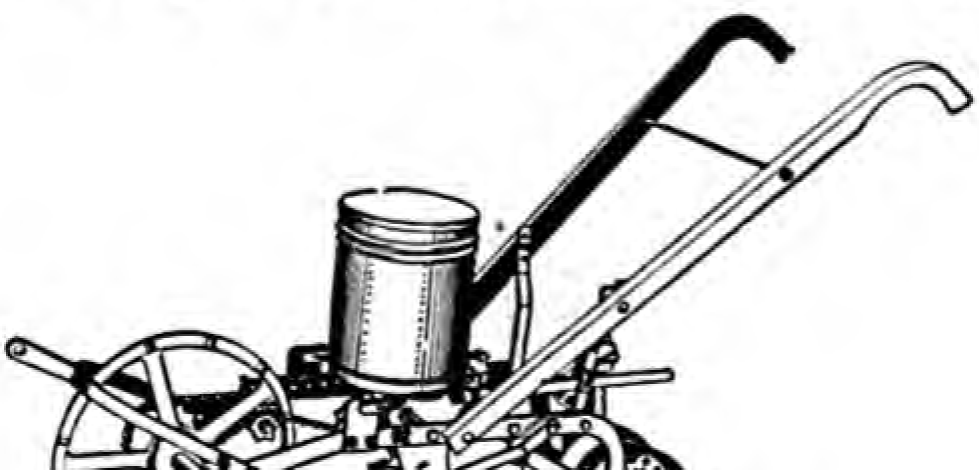


FIG. 273.—Planter equipped with hill drop. A chain transmits power to drive the seed plates and hill-drop valve.

of the frame, the type and location of wheels, the method of driving, and the seeding mechanism. The planter shown in Fig. 271 is equipped with a runner furrow opener, pitman drive, and a large, wide-tired wheel

which also drives the plates, covers the seed, and presses the soil around them. The most popular types of one-row walking planters used in the Cotton Belt are shown in Figs. 272 and 273.

258. One-row Riding Cotton Planter.—The most popular mule-drawn one-row riding type of cotton planter is shown in Fig. 274. It is designed to plant on the level, on beds, or in furrows. *Cotton is planted on ridges or beds to secure good drainage and allow the top of the bed to become warm early in the spring, which hastens germination of the seed.*

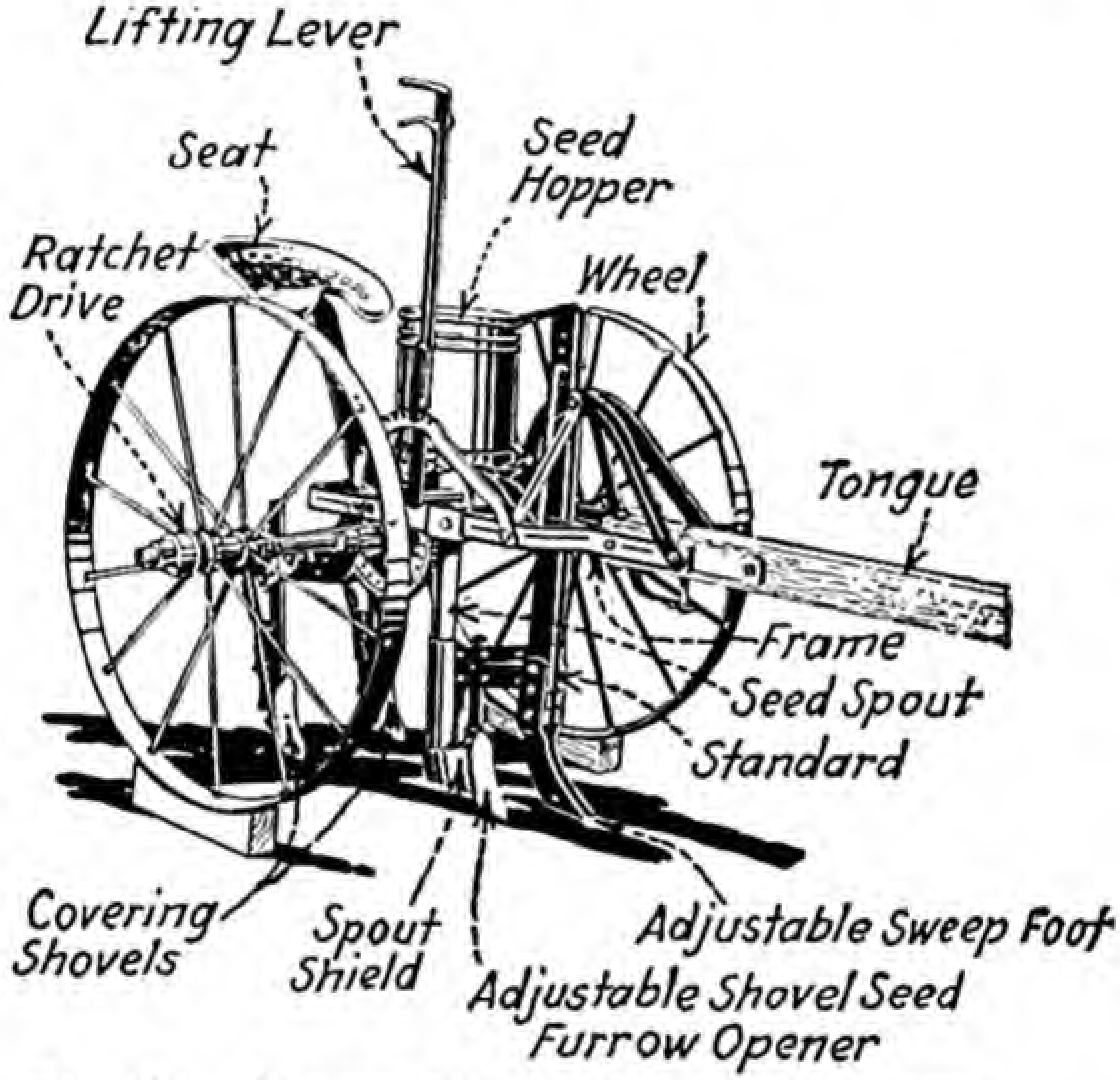


FIG. 274.—One-row riding cotton and corn planter.

259. Two-row Mule-drawn Cotton Planter.—The two-row mule-drawn cotton planter is really two units of the one-row planter combined. One axle serves for both units. The distance between rows can be adjusted from 32 to 42 inches.

260. Integral-mounted Tractor Cotton Planters.—When the general-purpose or row-crop type of tractor was developed, two-, three-, and four-row planters were designed and mounted on it. Many different arrangements have been tried, but the most popular types are shown in Figs. 277, 278, and 279. Two- and four-row types are available. Sweeps for knocking off the tops of the ridges are bolted to regular middlebreaker beams. The seed furrow opener and covering shovels are arranged behind the sweep in the same manner as they are on the horse-drawn planters. Gage wheels regulate the depth of the sweep and covering shovels. The large seed hoppers are mounted high enough above the breaker beams to permit the sweeps to be raised by means of a power

FIG. 275.—Single-row planter mounted on small tractor.

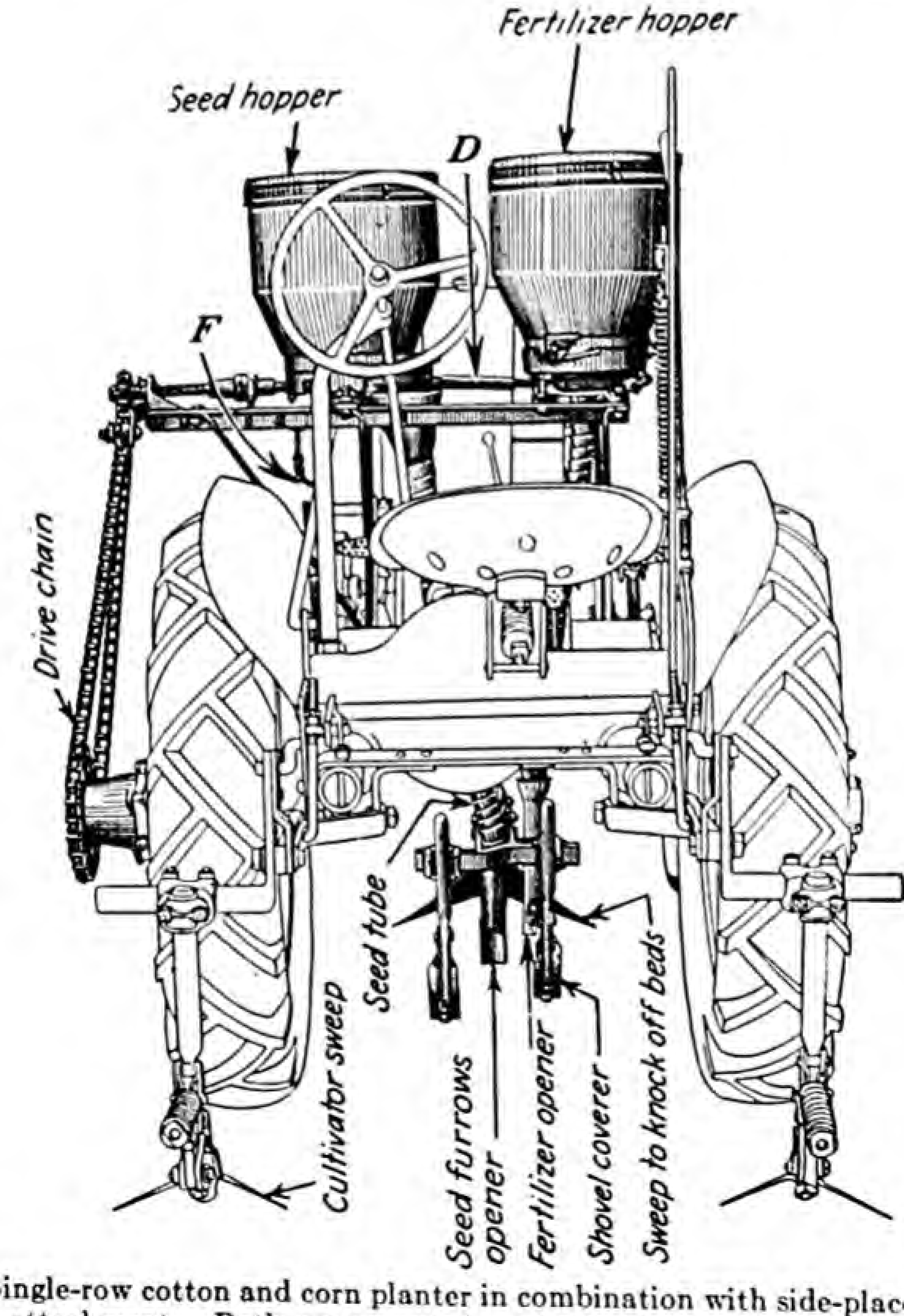


FIG. 276.—Single-row cotton and corn planter in combination with side-placement fertilizer attachment. Both are mounted to the front on a small tractor.

lift. Long flexible seed tubes conduct the seed from the hopper into the boot.

Where planting is done in listed furrows, middlebreaker bottoms can be substituted for the sweeps.

Plates for planting corn and sorghum are furnished as regular equipment. Fertilizer attachments can be supplied if desired.

261. One-row Tractor Cotton Planters.—The smallest size tractor equipped with single-row planting equipment for the planting of cotton, corn, and other row crops develops from 8 to 10 horsepower (Fig. 275). Small tractors such as shown in Fig. 276 have integral-mounted planting and fertilizing equipment, usually front or forward mounted. The

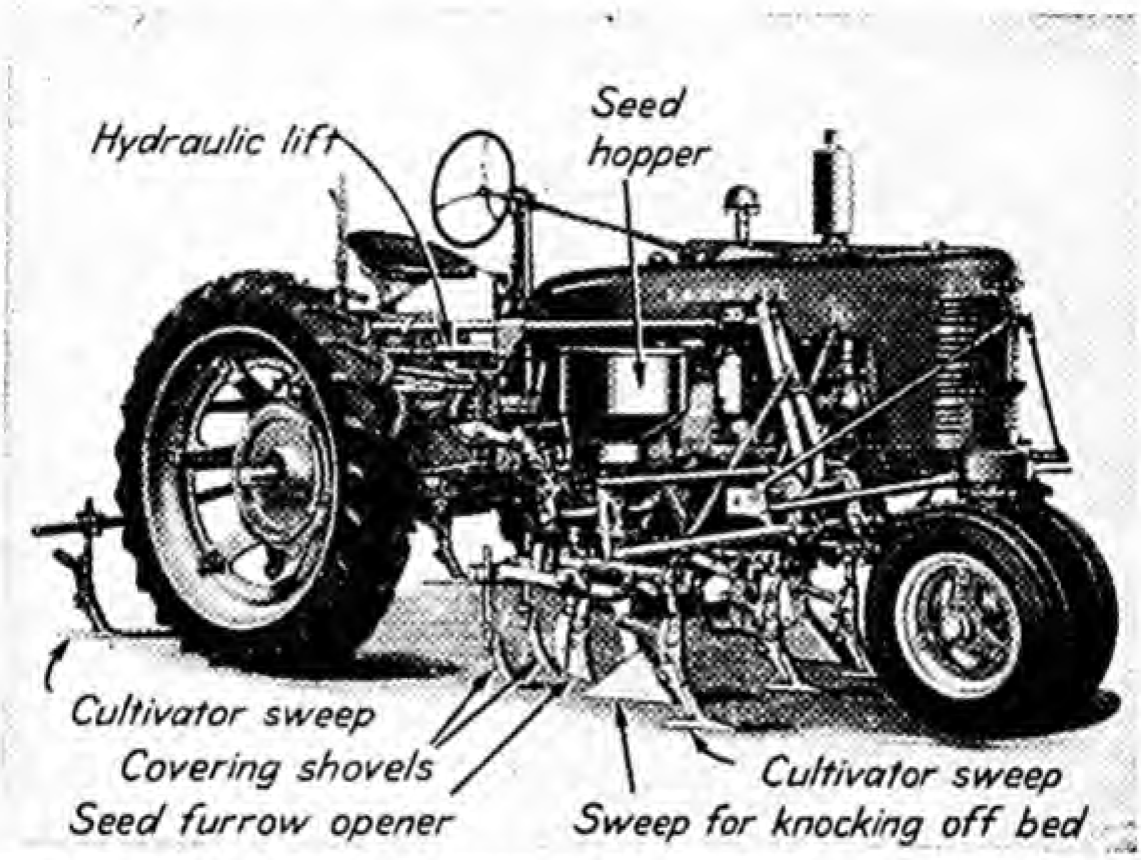


FIG. 277.—Two-row front-mounted cotton and corn planter for planting on beds used in combination with cultivator.

planter shown in Fig. 277 has standard hoppers, sweeps, seed and fertilizer furrow openers, and shovel coverers. Cultivator sweeps loosen the soil compressed by the tractor wheels.

262. Two-row Tractor Cotton Planters.—The tractors in Figs. 277, 278, and 279 are popular types of front-mounted cotton and corn planters. The planters in Figs. 277 and 278 are especially designed for planting bedded land, while the planter in Fig. 279 is designed for planting on level land. It is used in combination with cultivating equipment. The cultivator sweeps in front cultivate and destroy weeds on the sides of the beds, after which the large solid sweep cuts off and throws aside the dry top soil, leaving a clean moist area for the seed furrow opener and covering shovels. The cultivator sweeps in the rear cultivate and loosen the soil in the middles behind the tractor wheels.

Figure 278 shows a front-mounted combination fertilizer-planter. The large sweeps cut off the top of the bed, a stub-runner opener opens

a furrow for the fertilizer slightly to the front and to the side of the runner seed furrow opener, and shovel coverers ensure that the seed are well covered.

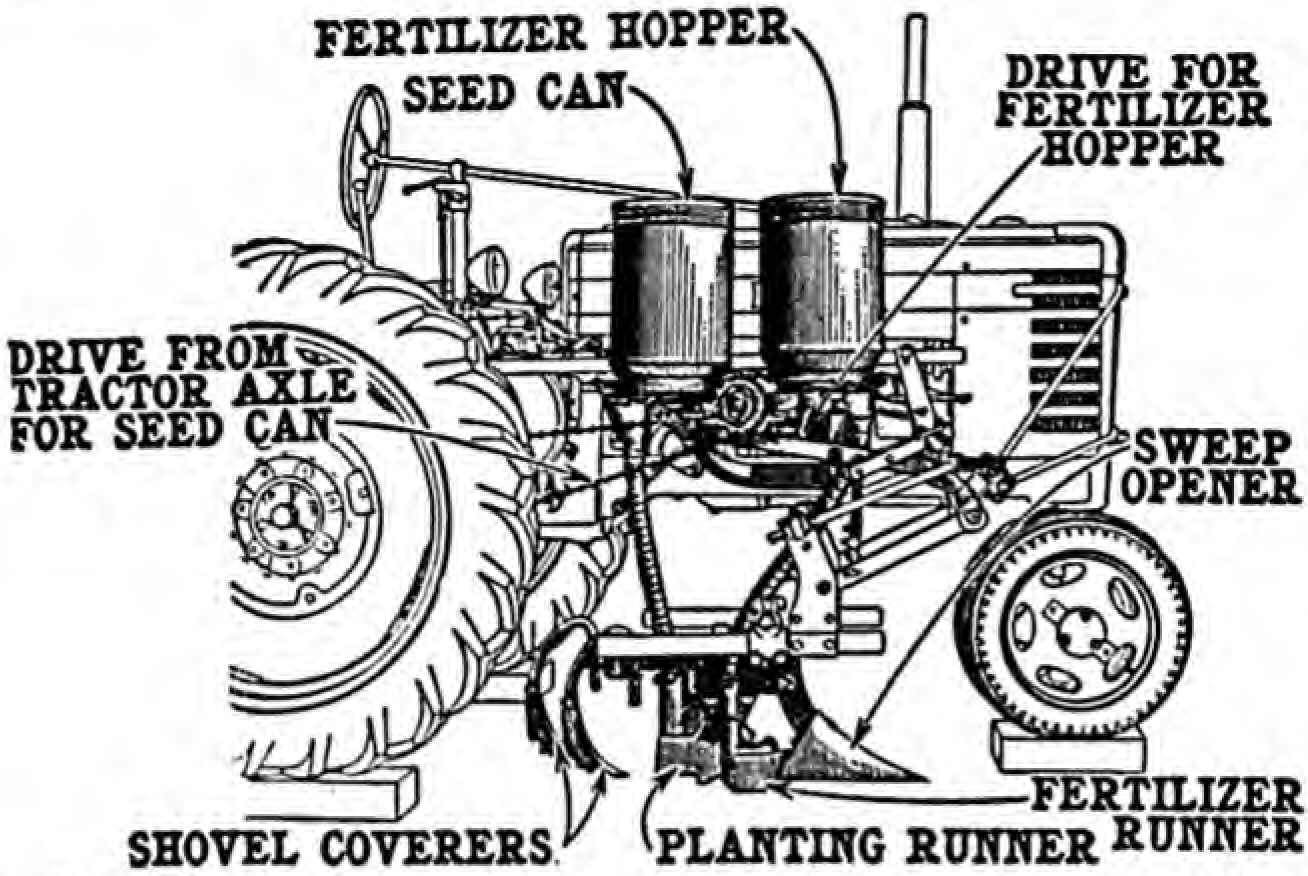


FIG. 278.—Front-mounted two-row cotton and corn planter and side-placement fertilizer attachment.

The two-row planter shown in Fig. 279 is equipped with fertilizer attachment. The fertilizer shovel opener is slightly ahead of and between the bedding disks, which throw soil over the fertilizer ahead of the runner seed furrow opener. All equipment is lifted by hydraulic power.

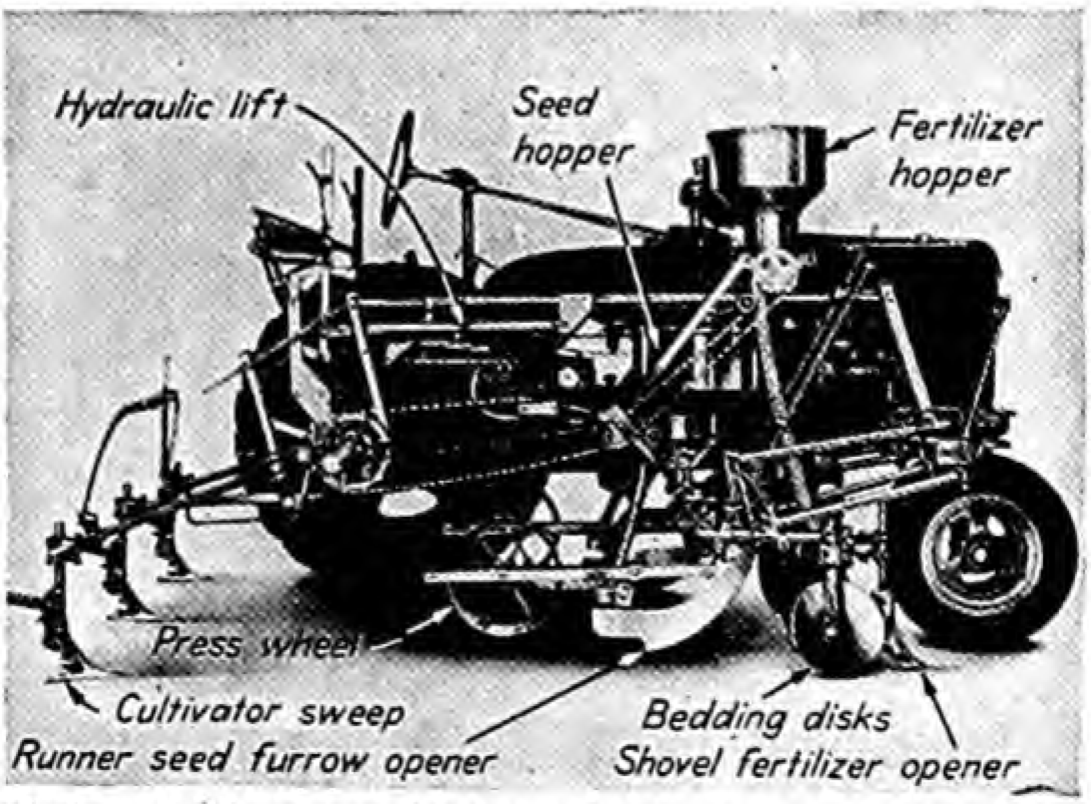


FIG. 279.—Front-mounted two-row planter and side-placement fertilizer attachment used in combination with cultivator.

All the tractor-mounted planters are driven from sprockets on the tractor axle. Means for adjusting all units such as sweeps, furrow openers, and covering shovels are provided.

263. Four-row Tractor Cotton Planters.—Most four-row integral-mounted cotton planters for planting on beds or in listed furrows are

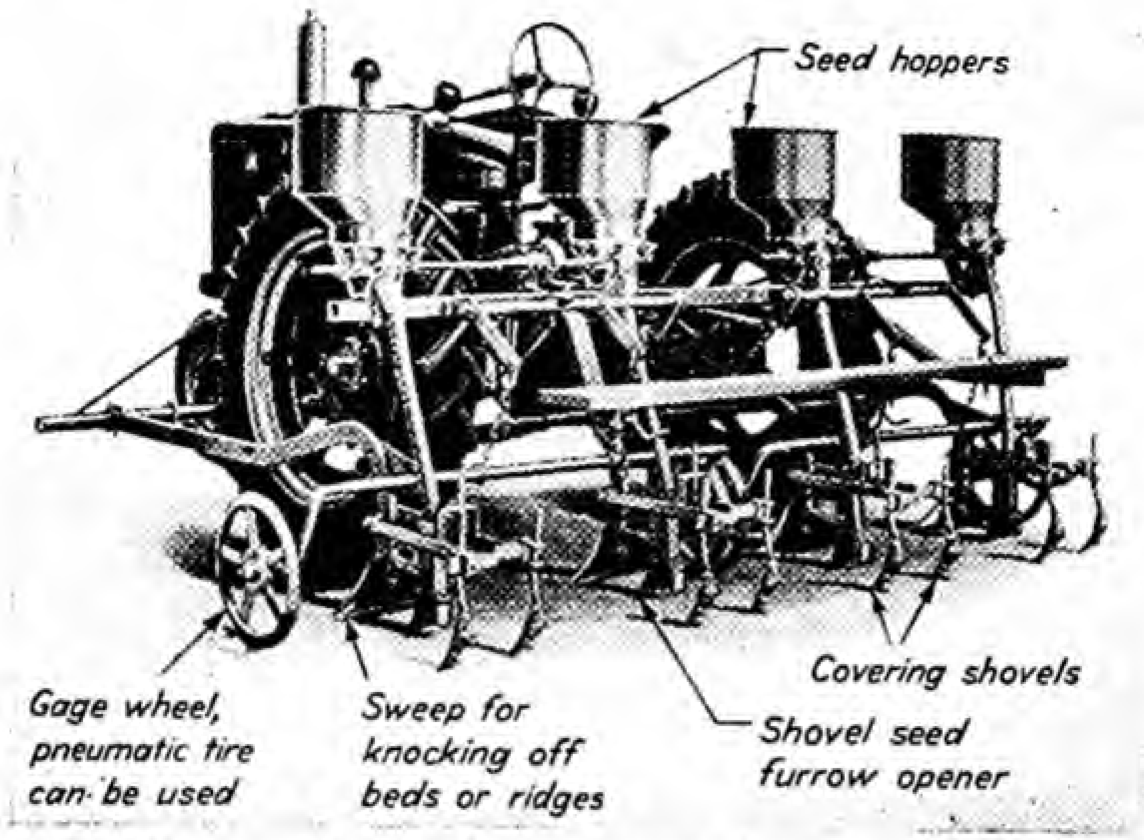


FIG. 280.—Four-row integral rear-mounted cotton and corn planter.

mounted to the rear of the tractor. This makes it possible to use heavy plow beams on which are attached either large sweeps or middlebreaker bottoms. The four-row planter shown in Fig. 280 has large hoppers for

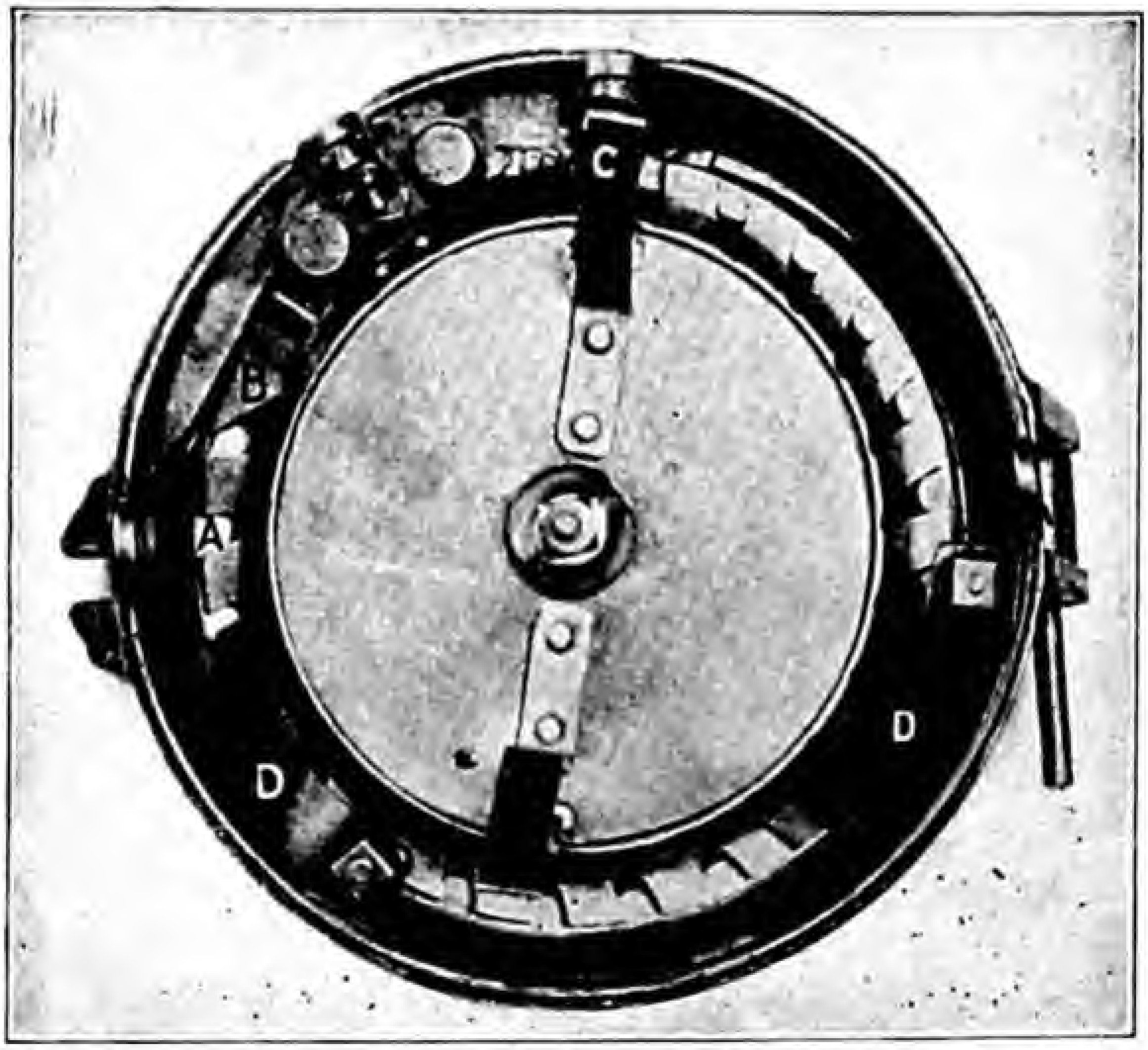


FIG. 281.—Cell-drop cotton-dropping mechanism with hopper removed: *A*, cell; *B*, cut-off; *C*, agitator arm; *D*, feed springs.

cottonseed, sweeps on the beams to knock off the tops of beds, and the regular shovel seed openers and coverers. Gage wheels aid in holding the sweeps at a uniform depth in the bed. Power lifts are used to raise

and lower the equipment. Fertilizer attachments may also be used with this type of planter.

264. Cotton-dropping Mechanisms.—Gin-run cottonseed is universally used for planting. This is seed with lint adhering to it, just as it comes from the cotton gin. Two types of dropping mechanisms are used on cotton planters. They are the *cell drop* and the *picker-wheel drop*.

265. The Cell Drop.—A typical cell drop is shown in Fig. 282. It consists of a plate with cells on the outer edge. As the plate turns

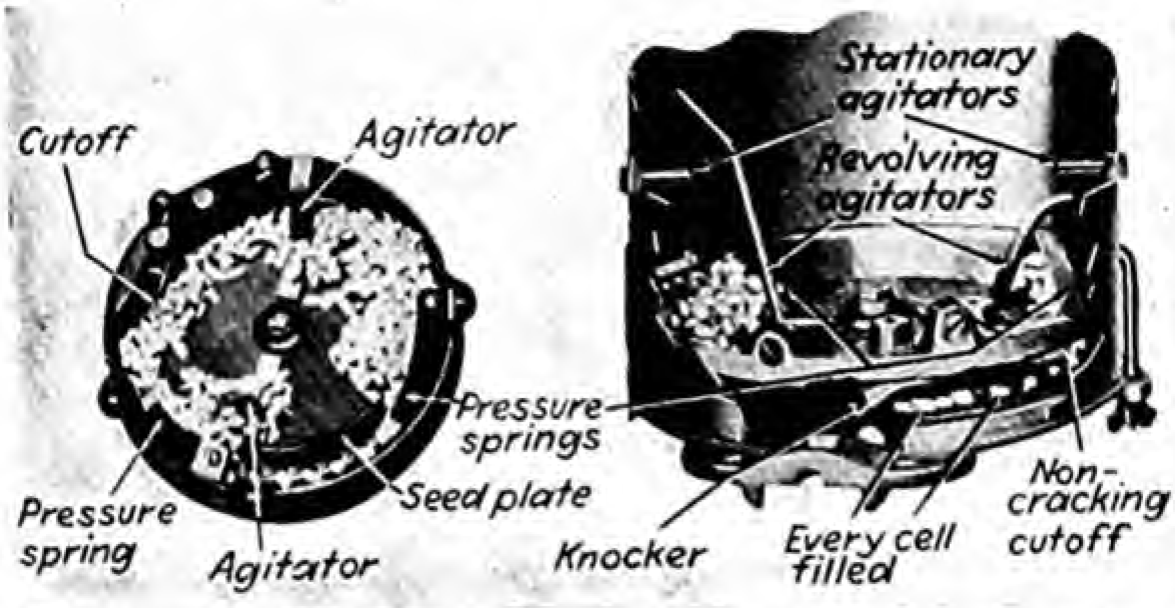


FIG. 282.—Cell-drop cotton-dropping mechanism showing the various parts.

the agitators separate and stir the seed, causing them to work down into the cells off a sloping collar, and under feed springs which gently force more or less seed into each cell. Then the yielding cut-off pushes back the surplus and, as the cells pass over an opening, a yielding spring-controlled knock-out partially drops into the cell, forcing the seed through the plate into the spout below. A small wheel with spurlike fingers projecting into each cell is also used as a knock-out device.

The manner in which the seed are distributed is shown in Fig. 283. With average-sized seed the quantity dropped by the cell drop ranges

FIG. 283.—Cottonseed dropped by cell-drop planter.

from ⅓ to slightly more than 1 bushel per acre. The quantity is varied by changing the speed of the plate and by changing plates which have different-sized cells.

Many claim that this type of drop injures a large quantity of seed, but, according to tests conducted by the author, the percentage of injury hardly ever is greater than 1 per cent.[1]

[1] *Tex. Agr. Expt. Sta. Bull.* 526, p. 19, 1936.

The cell drop is best suited to loose, loamy, and sandy soils and for planting delinted cottonseed.

Special planters, which work fairly satisfactorily, have been designed to drop cottonseed in hills.

266. The Picker-wheel Drop.—A representative type of the picker-wheel drop is shown in Fig. 284. It consists of a horizontal rotating agitator plate *A* with fins or fingers *B* radiating outwardly from the body of the plate. The fingers are so designed as to press the cotton seed downward on the picker wheel *C* revolving in an opposite direction, and at right angles against the movement of the agitators. This picker wheel really picks the seed from the mass forced down on it. The wheel is usually about ¾ inch wide and has notches, having a sharper slope on the front side than on the rear. It does not extend above the bottom of the hopper as a general rule.

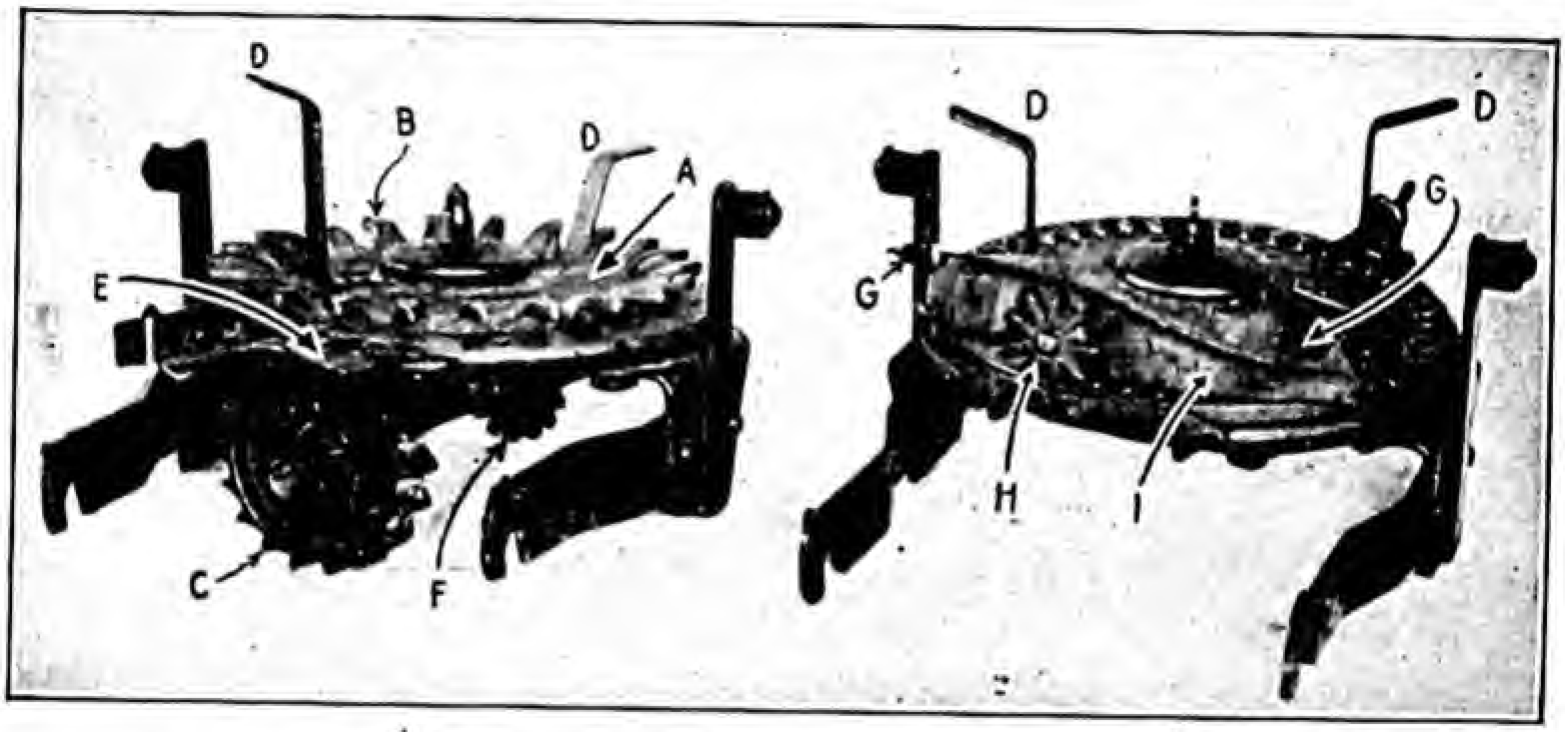


FIG. 284.—Cotton-dropping devices with hoppers removed: *A*, picker-wheel drop; *B*, cell drop.

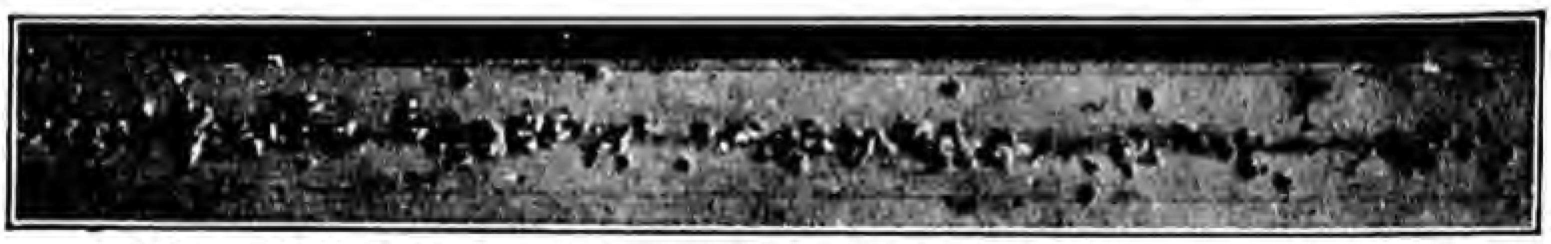


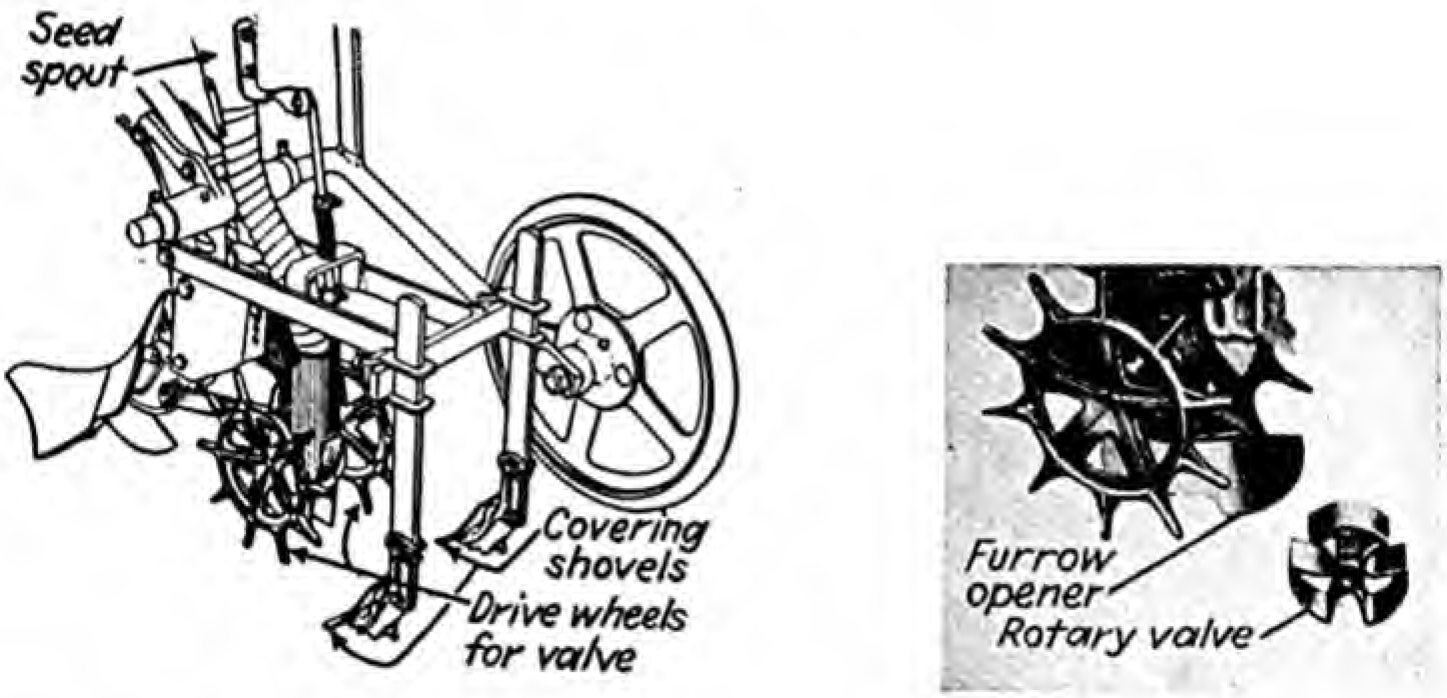
FIG. 285.—Cottonseed dropped by a picker-wheel dropping device.

The quantity of seed is regulated by exposing more or less of the picker wheel to the seed by means of a sliding gate shutter. The quantity of average-sized cottonseed planted can be varied from about ⅓ bushel to better than 3 bushels per acre. The manner of depositing the seed is shown in Fig. 285.

The picker-wheel drop injures an average of 0.20 of 1 per cent. This type of drop is best suited to black, heavy, crust-forming soils. A large

number of germinating plants is often necessary to break through a heavy crust formed on the top of the soil.

267. Hill-drop Mechanisms.—The first hill-drop mechanisms used consisted of cells spaced at suitable intervals in the planter plate and large enough to hold sufficient seed for one hill, or picker wheels having the notches in their surfaces so spaced as to drop the seed in hills. These hill drops were located in the bottom of the planter hopper, and it was necessary for the seed for each hill to fall from the hopper through the seed tube to the soil. In falling a distance of some 18 or 20 inches the seed became separated and scattered along the furrow to such an extent that it was difficult to distinguish one hill from another. Later someone conceived the idea of placing a valve in the lower part of the seed boot, low



A *B*

FIG. 286.—Hill-drop mechanism for tractor planter: *A*, showing position of hill drop; *B*, rotary valve for dropping hills.

enough to the ground to prevent the seed from scattering when they were dropped. Walking and riding horse-drawn planters and tractor planters are now available equipped with hill-drop mechanisms. Horse-drawn planters are equipped with a trip or rotary valve in the boot, while tractor planters are equipped only with the rotary-valve type of hill drop (Fig. 286). The trip-valve type will not withstand the strain of the higher speeds attained by tractors.

268. To Change from Cotton to Corn.—All cotton planters are equipped with hoppers so designed that the seed-dropping mechanism can be changed from cotton to corn or sorghum by changing the equipment in the hopper bottom. Figure 287 shows the parts involved when changing from cotton to corn or the reverse in one make of planter. Other makes are slightly different. There are no valves in the seed spout or tube; hence, corn is always drilled with this type of planter.

269. The Variable Drop.—Most of the cell-drop planters are provided with a variable-drop arrangement to vary the quantity of seed deposited. Some have several plates that may be changed.

270. Furrow Openers.—When planting cotton on beds, a large sweep is nearly always used in front of the regular seed furrow opener (Fig. 278). This sweep is carried on a heavy, strongly built and braced standard. The foot where the sweep is attached is adjustable to give the proper

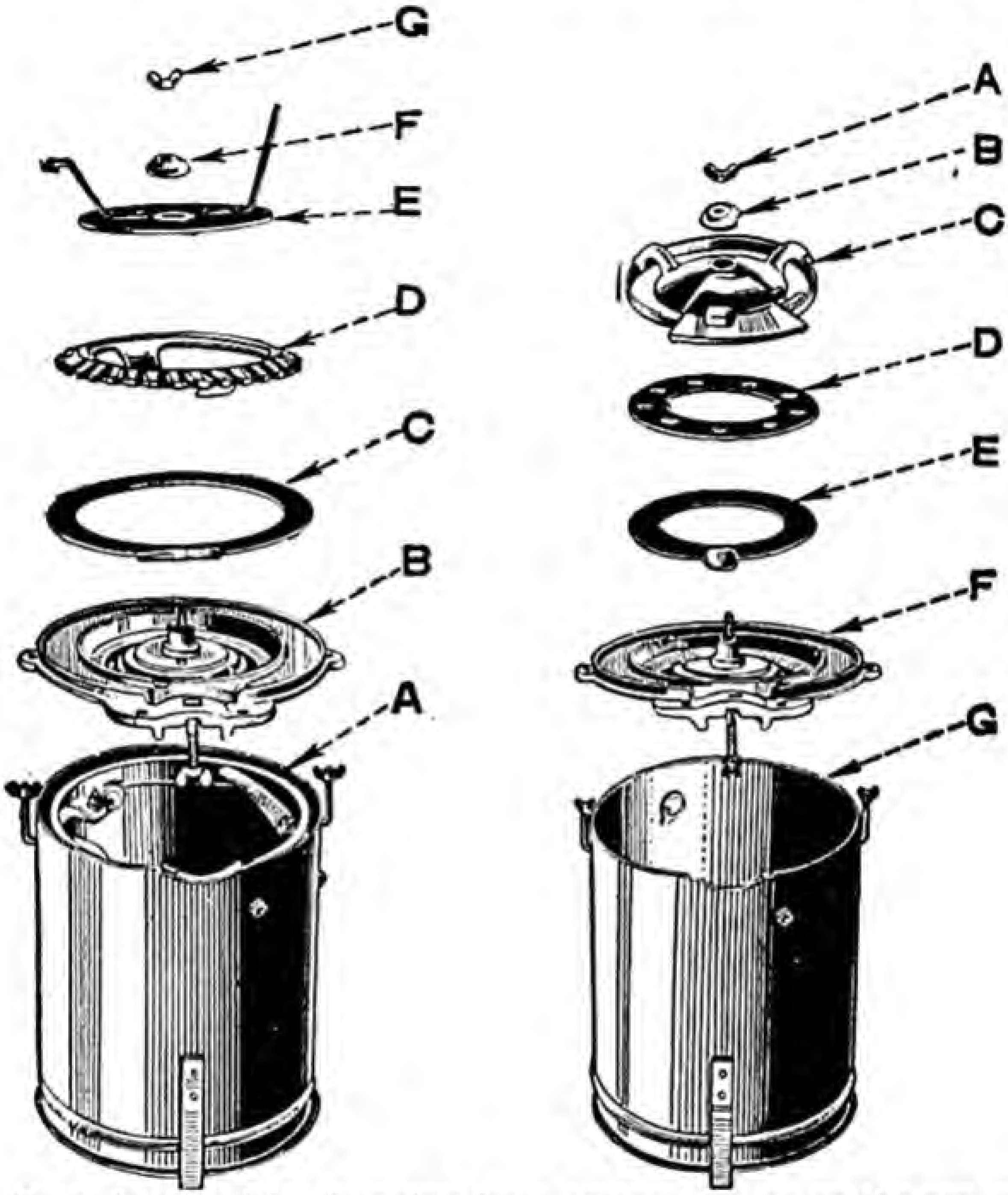


FIG. 287.—Parts involved in changing from cotton to corn or the reverse. Place the filler ring *A* in bottom of seed box. Put seed-box bottom *B* on box and replace: *C*, filler ring; *D*, cotton plate; *E*, agitator plate, *F*, washer; *G*, thumb nut. Lift box bottom *F*, from box *G* and turn over and remove: *A*, thumb nut; *B* washer; *C*, cut-off ring; *D*, corn plate; *E*, floor ring.

amount of suction. The sweep is used to shovel off the top of the ridges and level the ground somewhat, to destroy weeds, and to provide a clean moist soil for the seed.

If planting in the listed or "water furrow," a middlebreaker bottom is substituted for the sweep.

The regular seed furrow opener is carried to the rear of the standard and almost directly below the axle. In this position the seed tube or seed spout is almost perpendicular. A furrow opener for the seed may be either a double-pointed, reversible shovel (Fig. 277), or a runner-shoe

opener (Fig. 278). Shields are used with the shovel openers (Fig. 274) to prevent the soil falling back into the furrow before the seed are deposited. The author found[1] that better stands of cotton were obtained when narrow shovel openers $1\frac{1}{2}$ inches wide were used than when openers $2\frac{1}{2}$ inches or wider were used; less soil was disturbed and better moisture conditions were obtained.

Both the sweep and the subopener are raised together. When they are raised, the seeding mechanism is automatically disengaged, either by lifting the seed box off the drive gears or by disengaging a clutch on the axle.

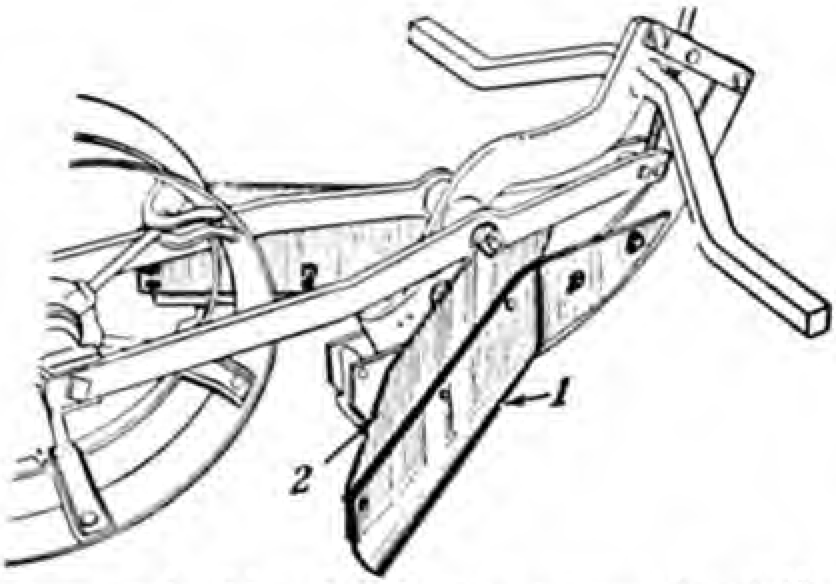


FIG. 288.—Wings used on each side of a furrow opener level the bed. A level bed is essential in flame cultivation.

271. Covering Shovels.—The covering shovels are attached to a frame that works in conjunction with the raising of the standard. The covering shovels are raised and lowered with the furrow opener. The covering shovels, however, can be raised independently by means of a foot lever. Double-pointed and reversible shovels are attached to shanks that can be adjusted up and down and tilted forward or back to vary the suction of the shovels. The shanks can be set either inside or outside the covering frame and may be staggered to allow trash to work through. The covering shovels are equipped with either the spring trip, the pin break, or the friction trip.

A press-wheel attachment (Fig. 279) can be used behind the covering shovels if desired.

272. Special Attachments.—A fertilizer attachment can be put on or removed easily, as shown in Figs. 278 and 279. The fertilizer feeding mechanism is driven by a chain and sprocket. A spout conducts the fertilizer to the ground just ahead and to the side of the seed furrow opener where it is mixed with the soil.

Special plates for planting kafir, milo maize, peas, and peanuts can be secured and used on all cotton and corn planters.

[1] *Texas Agr. Expt. Sta. Bull.* 621, p. 8, 1942.

Press-wheel attachments, disk coverers, sweeps, and middlebreaker bottoms are all extra equipment which can be obtained when desired.

273. Duty of Cotton Planters.—With a one-row planter, either walking or riding, an average of 7 acres can usually be planted in a 10-hour day. Gabbard and Jones[1] found that a two-row horse-drawn planter will plant an average of 14.3 acres, while a two-row tractor-drawn planter will plant 23.3 acres in a 10-hour day. A four-row tractor-mounted planter will plant an average of 35.7 acres in a 10-hour day.

274. Draft.—The one-row riding cotton and corn planter is usually drawn by two horses or mules. When listing or planting in heavy soils, three horses are often desirable. Medium- and large-sized general-purpose row-crop tractors have ample power for easy handling of two- and four-row tractor-mounted planters.

VEGETABLE, BEET, AND BEAN PLANTERS

The growing of vegetables, beets, and beans on a large scale requires special multiple-row planting equipment suitable for operation with various sizes of tractors.

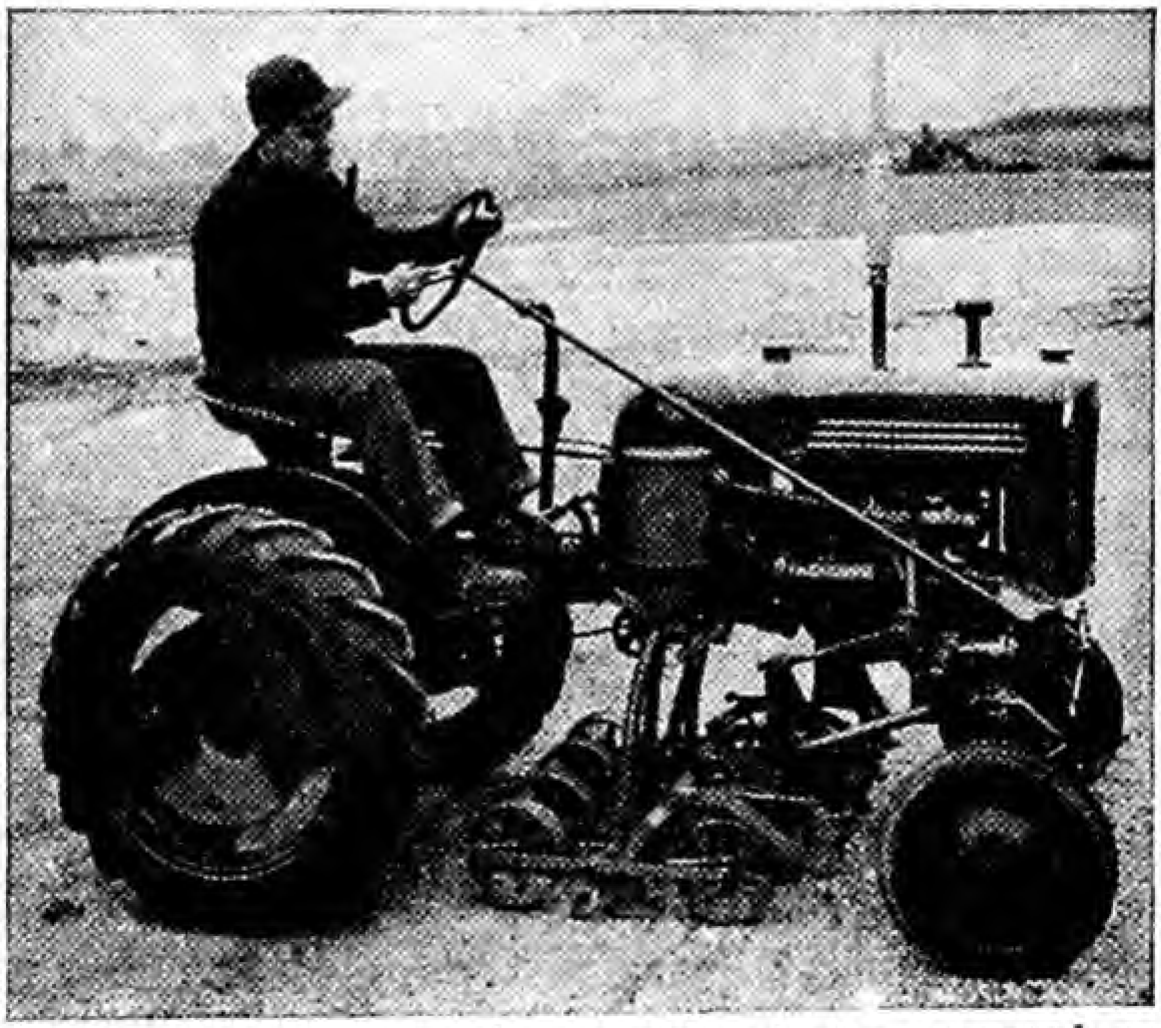


FIG. 289.—Four-row forward-mounted vegetable planter mounted on 8-horsepower tractor.

275. Vegetable Planters.—Vegetable planters can be obtained in many sizes ranging from the small, single-row, man-pushed garden planter to the tractor-operated planter having several planting units. Figure 289 shows a four-row forward-mounted vegetable planter designed for a small-sized 8-horsepower tractor. The planter shown in Fig. 290

[1] *Tex. Agr. Expt. Sta. Bull.* 362, p. 13, 1927.

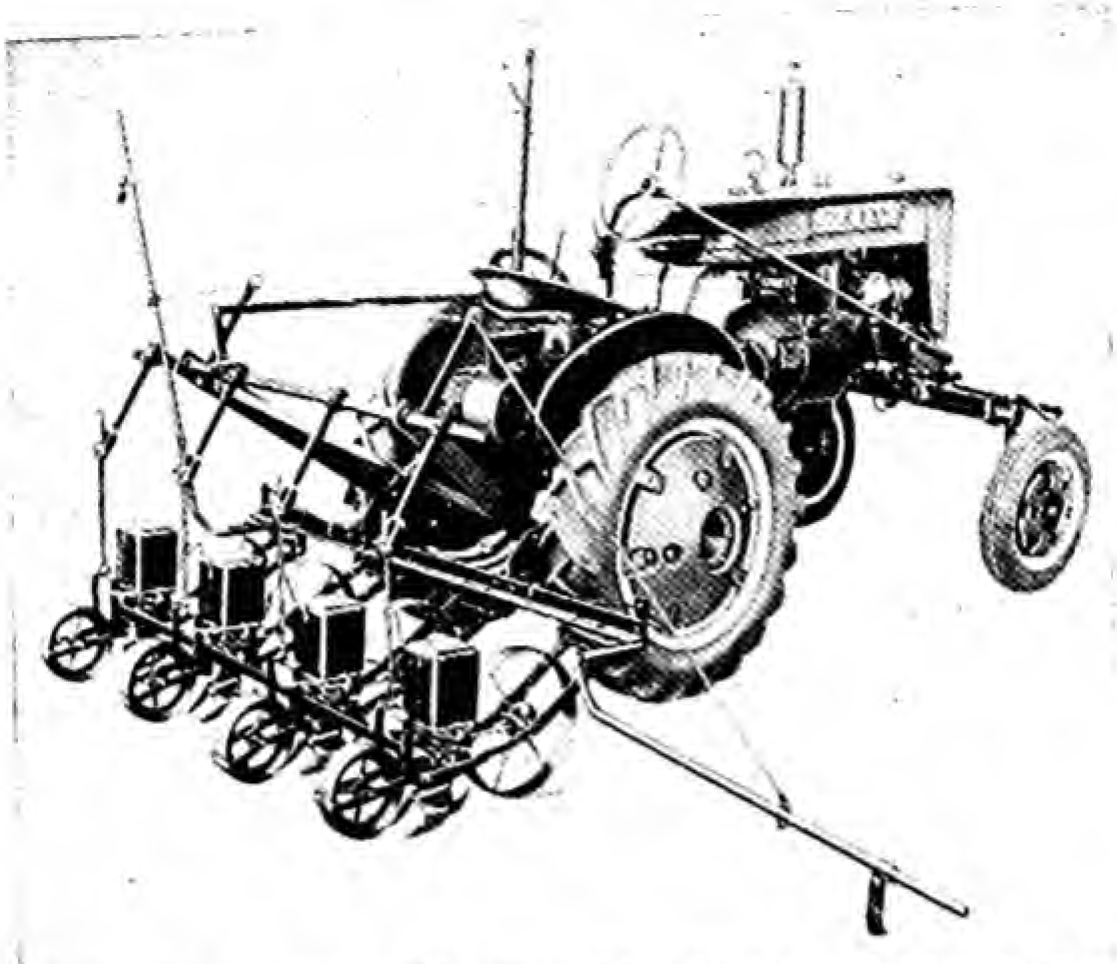


FIG. 290.—Four-row trailing power-lift vegetable planter suitable to be used with small-sized tractor.

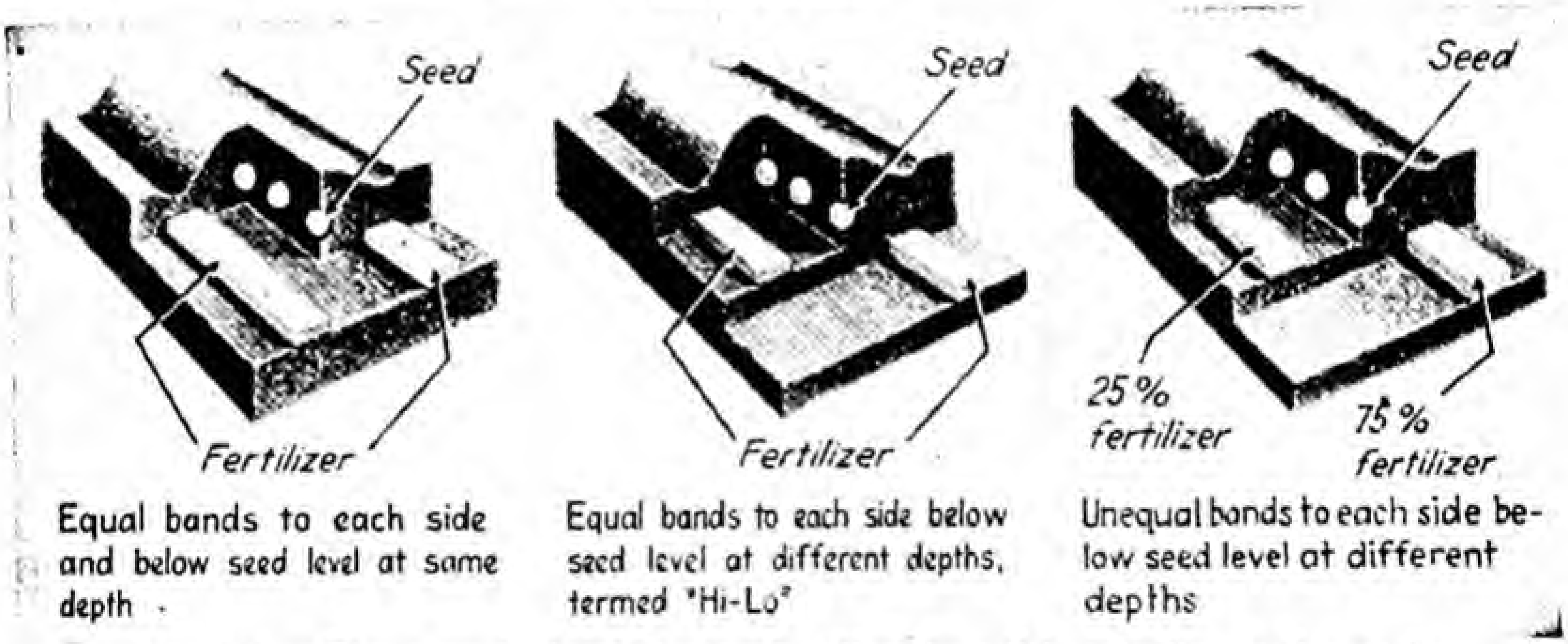


FIG. 291.—Three methods of placing fertilizer in soil in relation to the seed.

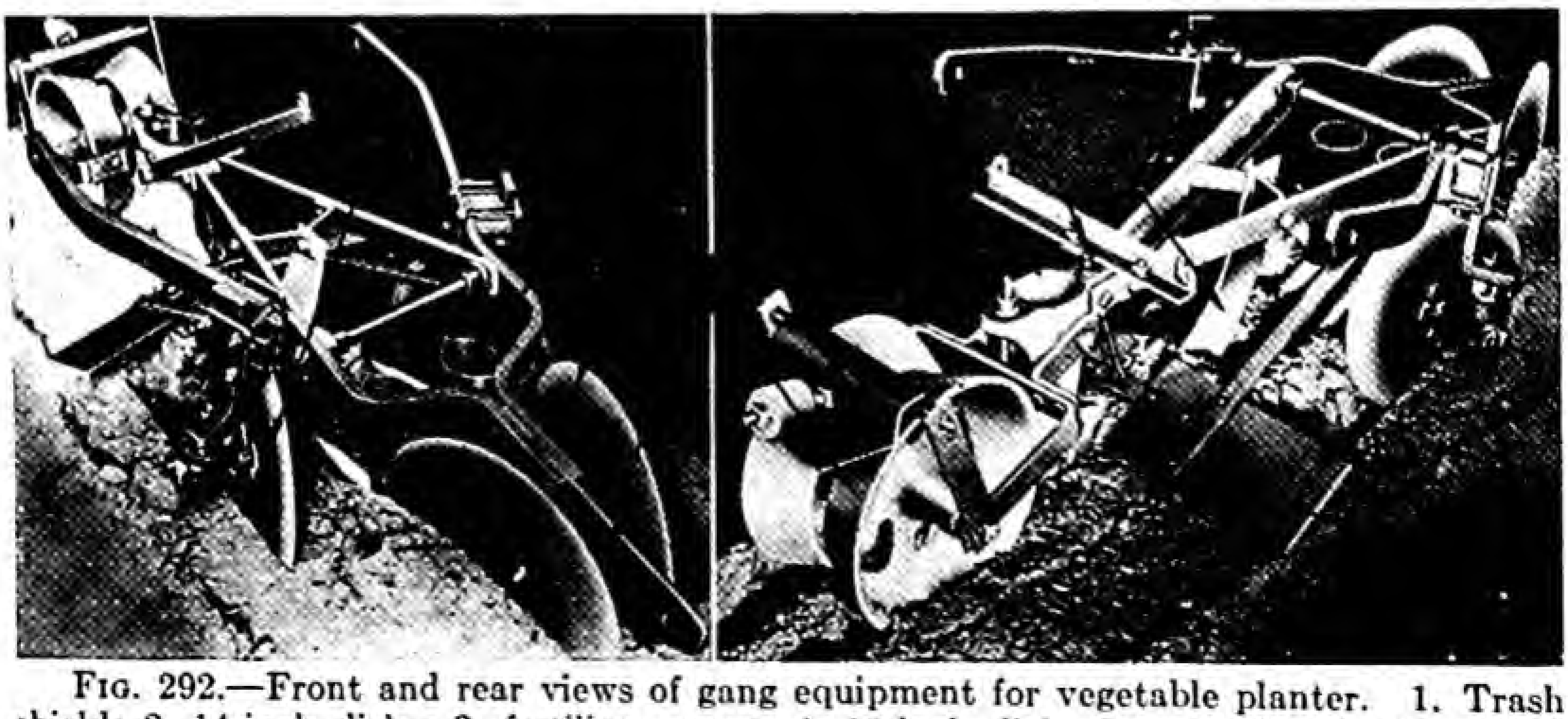


FIG. 292.—Front and rear views of gang equipment for vegetable planter. 1. Trash shield; 2. 14-inch disks; 3. fertilizer spout; 4. 12-inch disks for covering fertilizer and reforming ridge; 5. runner furrow opener; 6. leveling board; 7. adjusting screw; 8. seed spout; 9. seed depth regulator; 10. press wheel; and 11. wheel scraper.

is a four-row trailing direct-connected tractor vegetable planter. It is lifted by tractor power. Each planting unit for these planters floats independently in a frame so that the unit can automatically adjust itself to the contour of the ground. The wheel in front serves both as a gage

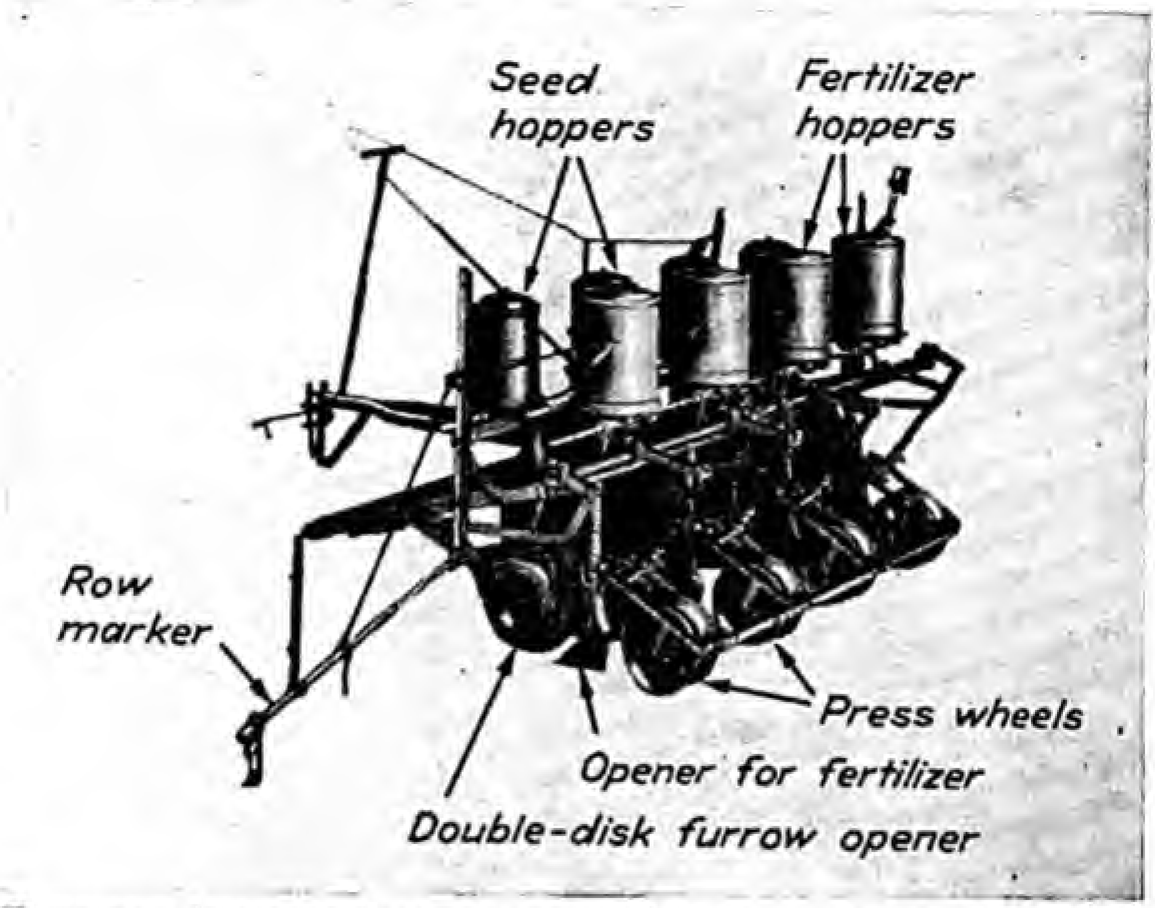


FIG. 293.—Four-row bean, soybean, corn, and beet planter for tractor operation. The planter is equipped with fertilizer hoppers, boots, and openers, as well as shoe-type row markers and power lift. It is mounted on pneumatic tires.

wheel and a drive wheel. The wheel in the rear serves as a gage wheel and a press wheel. The planter units can be arranged to plant from one to six rows. Adjustments can be made for row spacings from 12 to 22 inches.

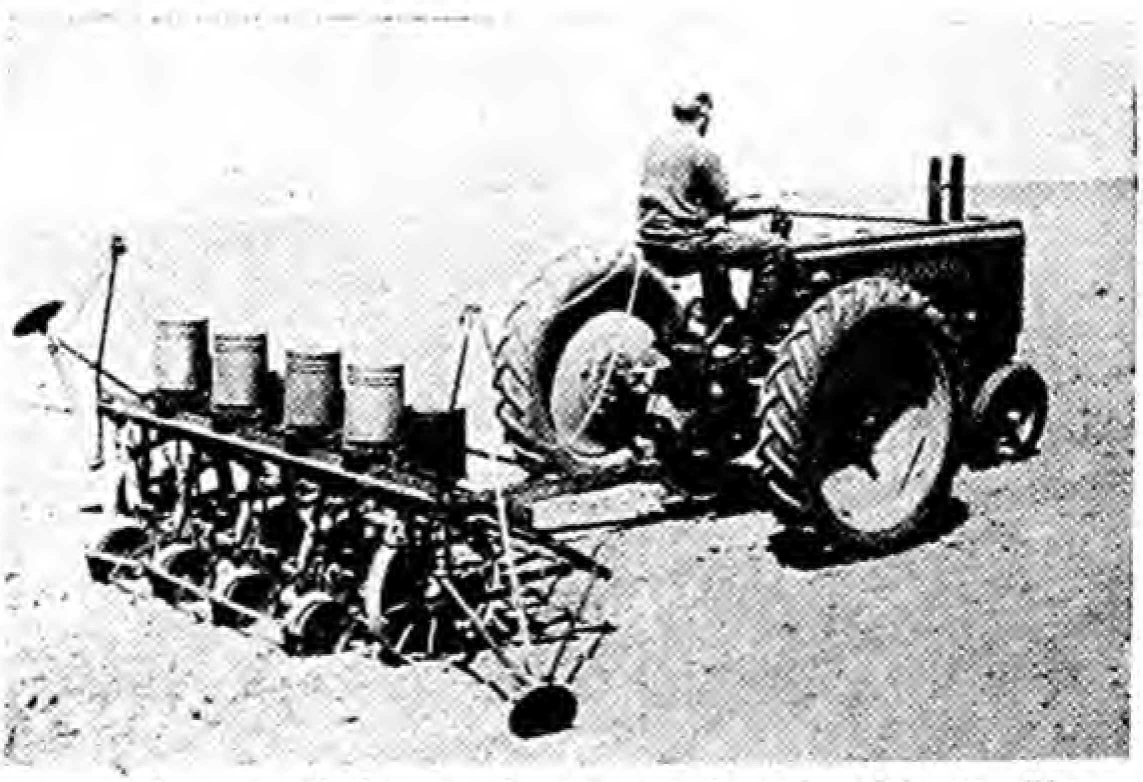


FIG. 294.—Four-row beet and bean planter equipped with fertilizer attachment in operation.

276. Beet and Bean Planters.—The production of beets for sugar and soybeans for oil and plastics has brought about new developments in planting equipment for these crops. Figures 293, 294, and 295 show

four- and six-row beet and bean planters. Adjustments are provided to obtain a wide variety of row spacings from 18 to 40 inches. The six-row machine can be adjusted to row spacings from 18 to 24 inches.

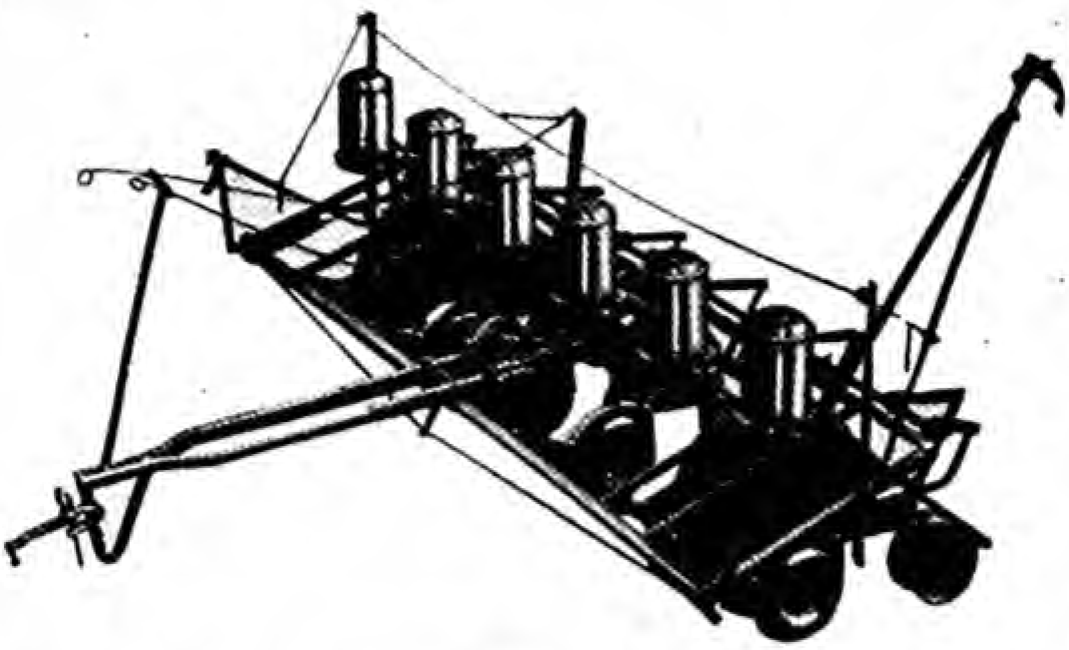


FIG. 295.—Six-row bean, soybean, corn, and beet planter for tractor operation, which can be converted into a four-row planter. It is equipped with shoe-type row marker, power lift, double-disk furrow openers, and open-center press wheels.

When converted into a four-row planter row spacings can be obtained ranging from 26 to 40 inches.

The planters are supported on two large wheels, which may be equipped with pneumatic tires. These wheels operate the power lift.

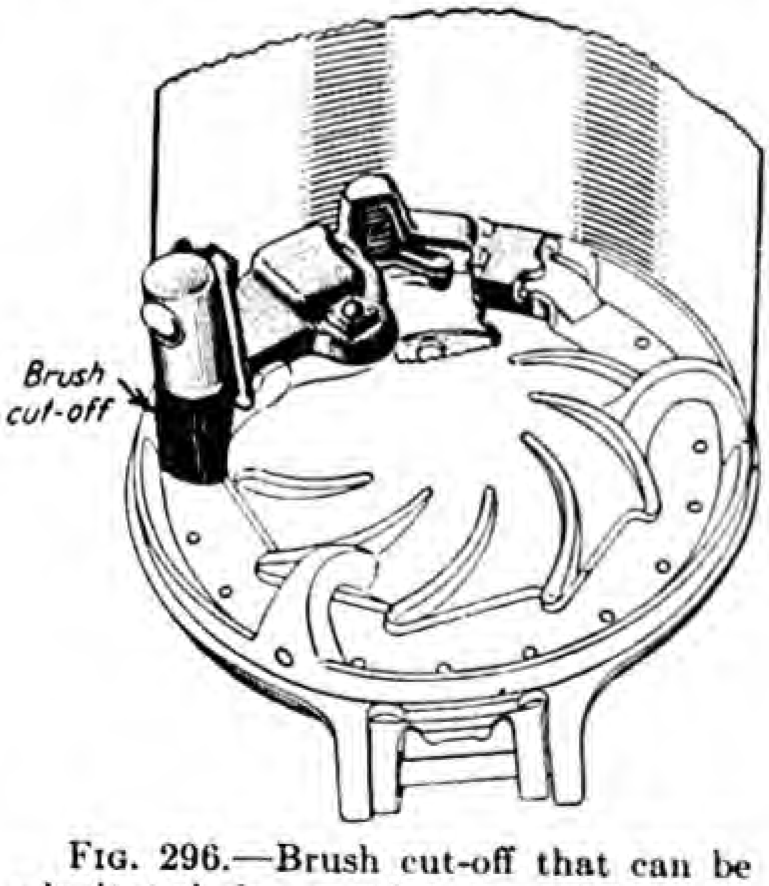


FIG. 296.—Brush cut-off that can be substituted for regular cut-off in seed hopper.

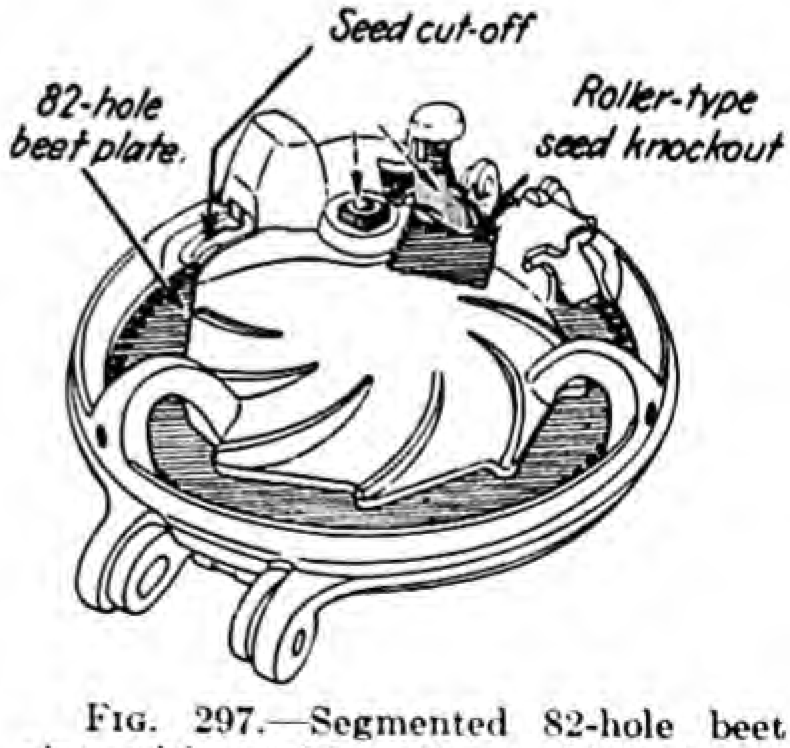


FIG. 297.—Segmented 82-hole beet plate with spurlike roller seed knock-out. Part of the cover is cut away to show knock-out.

Seed plates can be obtained for planting beans, soybeans, corn, beets, and other small seed crops. The dropping mechanism for beets is designed to plant segmented seed, that is, plant single beet seed after

the pods have been broken up. Special brush cut-offs (Fig. 296) and small spurlike rollers with projections to punch the seed through and out of the plate cell (Fig. 297) are available. Various-sized sprockets are

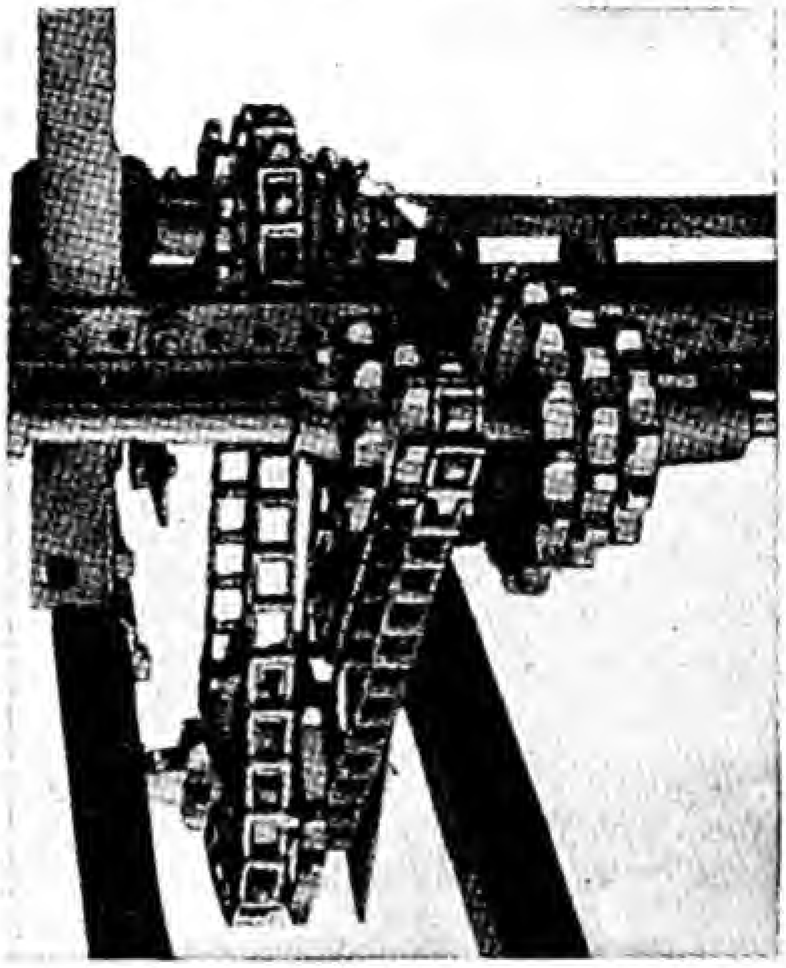


FIG. 298.—Number of sprockets of different sizes necessary to give twelve different speeds and rates of seeding.

provided to obtain up to twelve different plate speeds to plant high and low rates of seed (Fig. 298). Runner and double-disk types of furrow openers are interchangeable (Fig. 299). The double-disk opener is provided with removable depth-gage bands or drums that fit on the sides

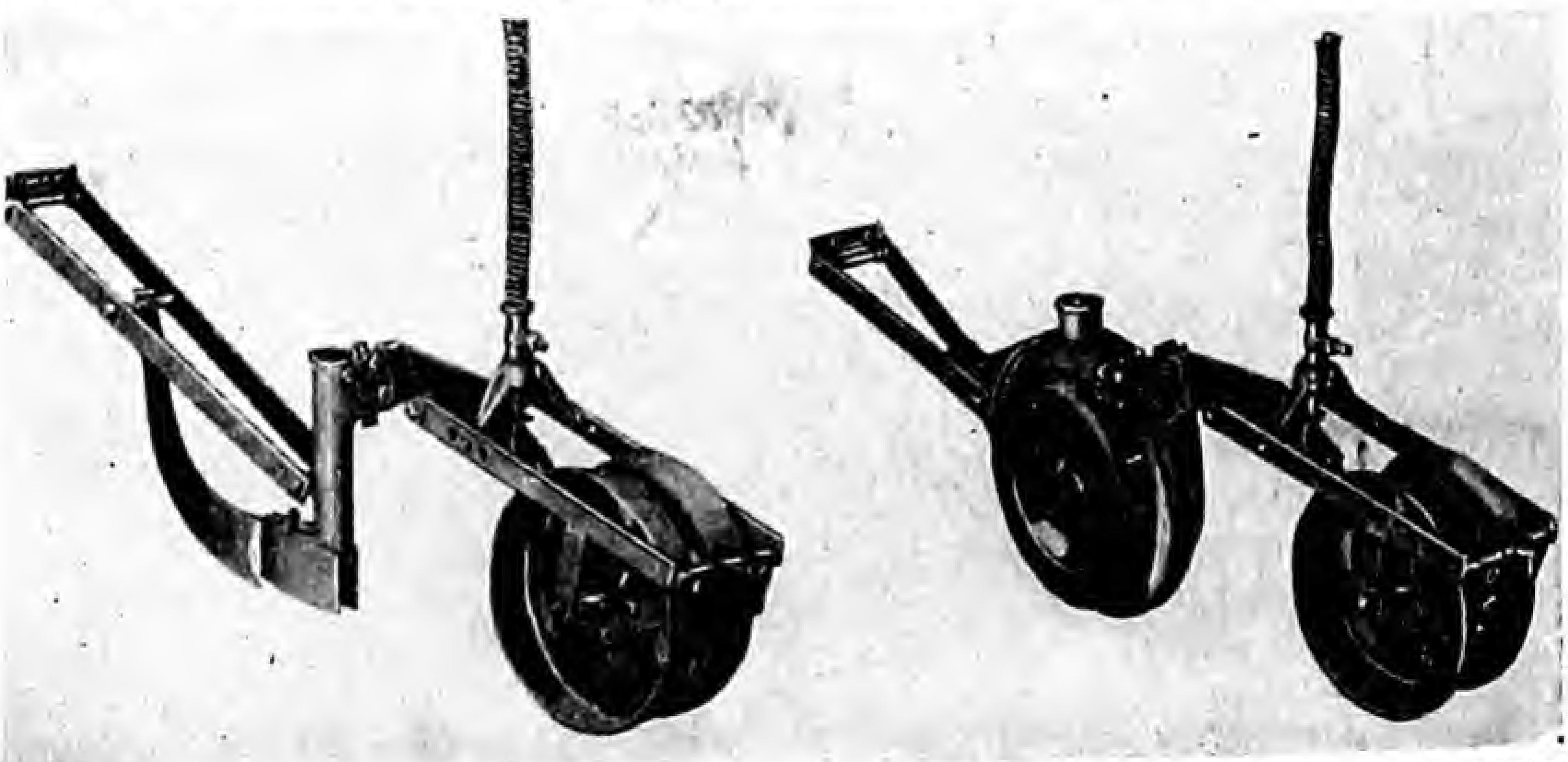


FIG. 299.—Runner and double-disk furrow openers are provided with concave open-center press wheels under adjustable spring pressure.

of the disks (Fig. 300). Narrow and pointed shoe-type furrow openers for fertilizer are attached to the planter gangs so that the fertilizer can be placed to the side and below the seed level (Fig. 301).

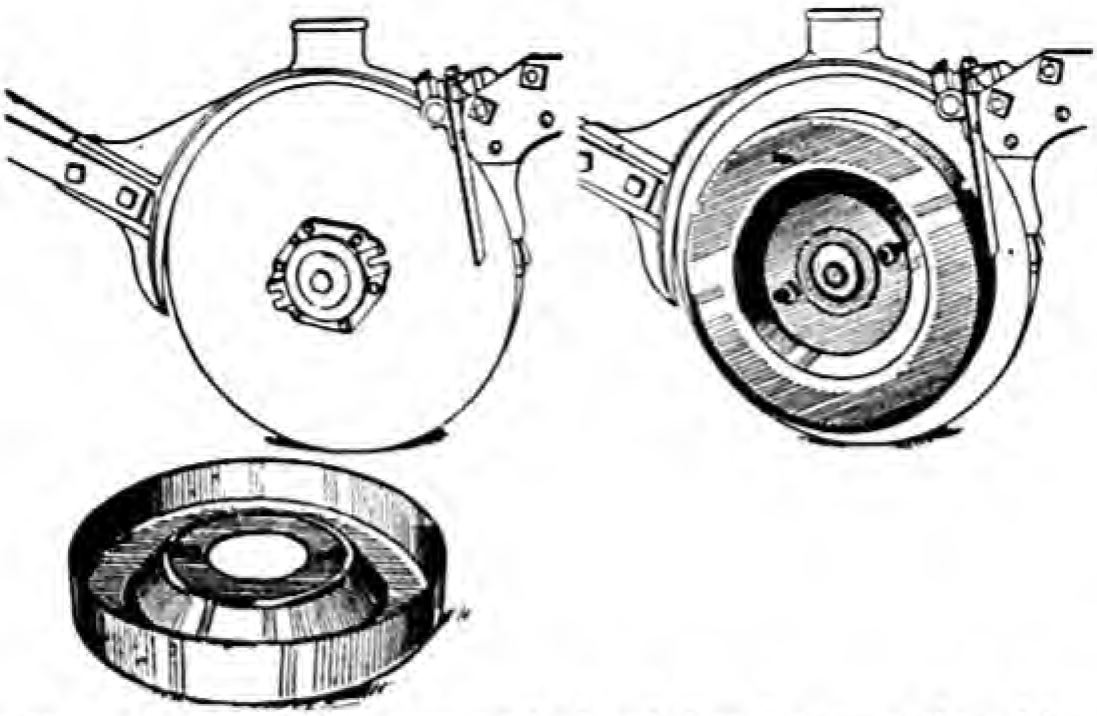


FIG. 300.—Disk furrow opener with depth band removed and in place.

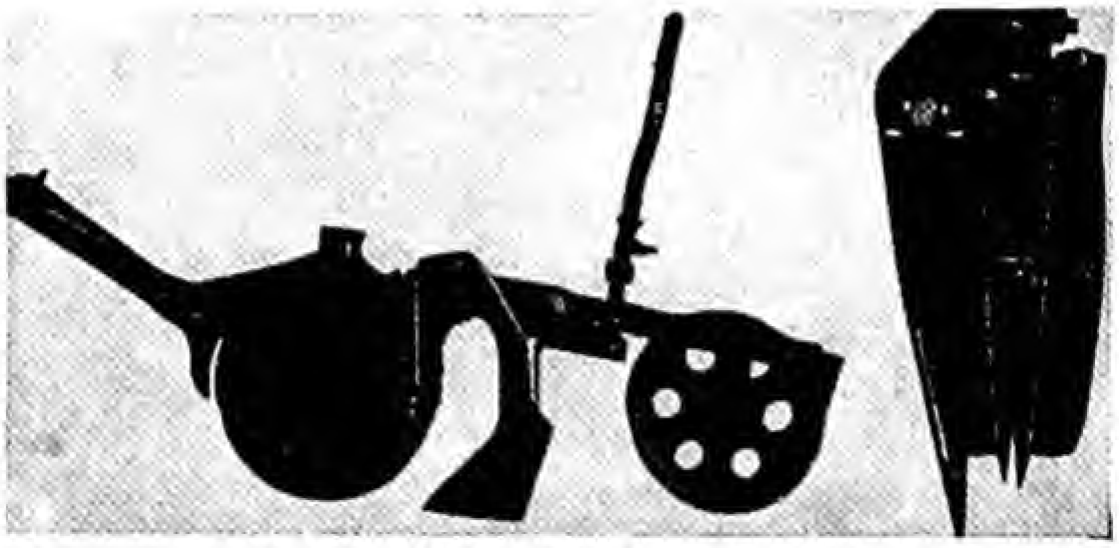


FIG. 301.—Planter gang equipped with fertilizer furrow opener to place the fertilizer to the side and below the seed level.

POTATO PLANTERS

The slow laborious hand dropping of planting potatoes has been largely supplanted by mechanical planters that open a furrow, drop and space the seed pieces at various distances, place fertilizer to the sides and below the level of the seed, and cover both seed and fertilizer at the desired depth.

There are three types of potato-dropping mechanisms: the automatic, the high-speed automatic, and the semiautomatic.

277. The Automatic Planter.—The dropping mechanism of the automatic potato planter (Figs. 302 and 303) consists of a picker wheel to which are attached from three to twelve picker arms (Fig. 304). The picker wheel revolving on the main axle causes the picker arms and picker head to pass through the picking chamber containing the seed. Each picker head is equipped with two sharp picking points which pick out a single seed piece, carry it over to the front and, as the arm starts downward in its rotation, releases the seed or forces it off the points, dropping it into the seed spout, which guides it into the furrow made by the furrow opener. The seed piece is forced off the picker points by the

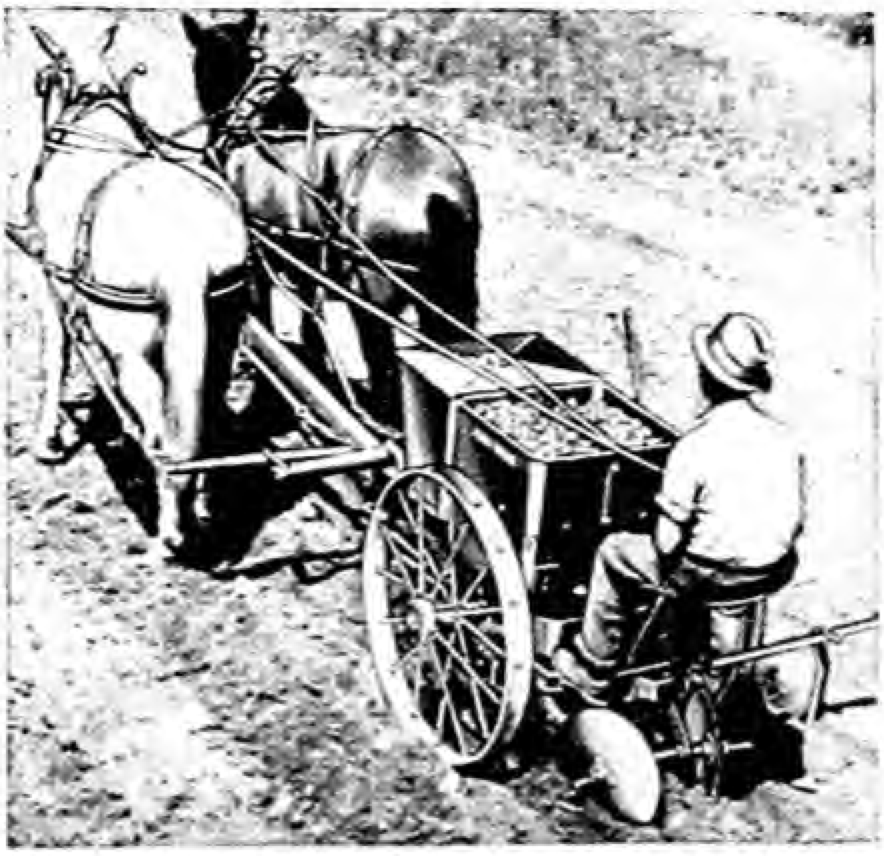


FIG. 302.—Single-row automatic horse-drawn potato planter equipped with fertilizer attachment.

FIG. 303.—Front view of two-row automatic tractor-drawn potato planter equipped with fertilizer attachment, tractor hitch, and wheels with 6.50 × 24 pneumatic tires.

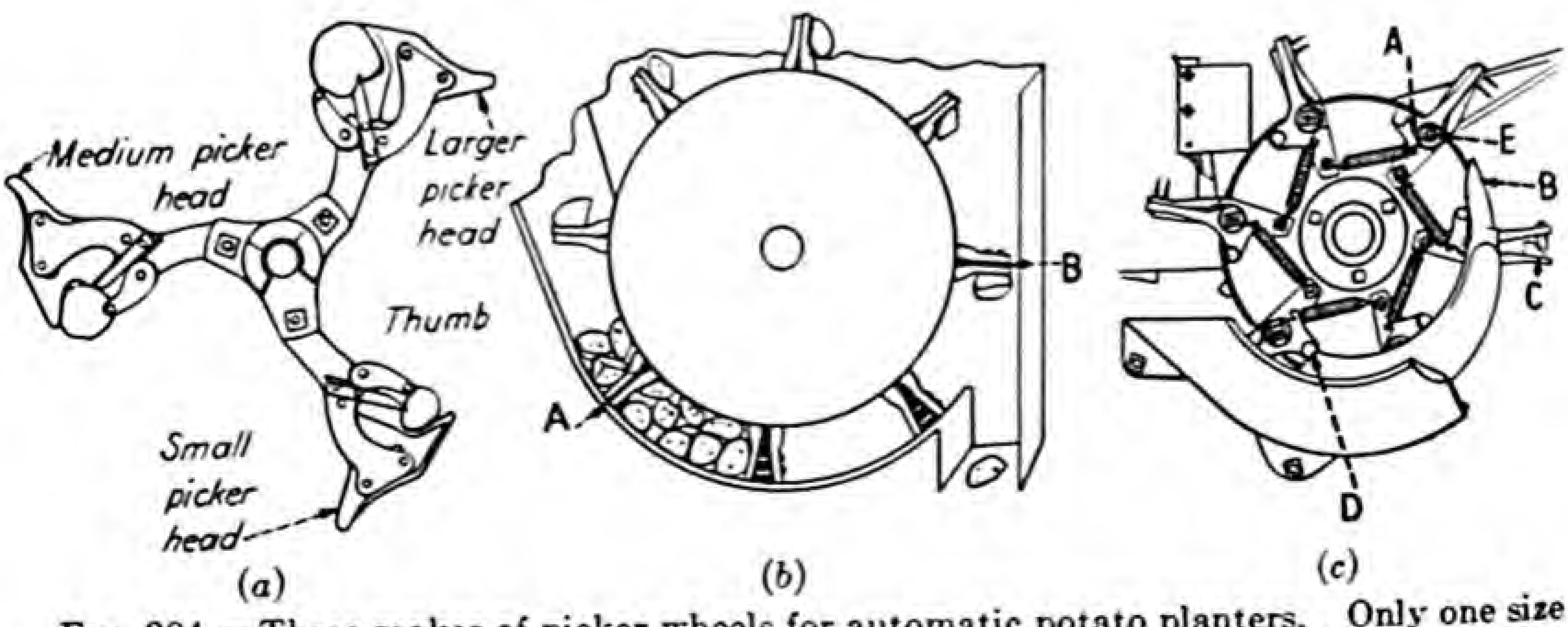


FIG. 304.—Three makes of picker wheels for automatic potato planters. Only one size picker head is used at one time. (a) Picker wheel showing three sizes of picker heads. (b) Picker wheel and arms with housing cut away to show how seed pieces are picked from the picking chamber. (c) Picker wheel showing how cams open the picker arm jaws to release the seed.

opening of the picker arm when the base of the arm contacts a cam (Fig. 304). The distance between seed pieces in the furrow is varied by changing the speed of rotation of the picker wheel. The quantity of seed flowing into the picking chamber is controlled automatically.

FIG. 305.—Two-row tractor-drawn automatic potato planter equipped with fertilizer attachment in operation.

A man rides on the two-row tractor-drawn planter to see that the hoppers are kept full and that the picking chamber does not choke (Fig. 305).

278. The High-speed Automatic Planter.—The high-speed automatic potato planter is equipped with two picker wheels, each having eight picker arms. These two picker wheels revolve only half as fast as when a single picker wheel is used at a normal speed. High-speed planting is done at twice the normal speed, but the picker arms do not revolve any faster than does the single wheel.

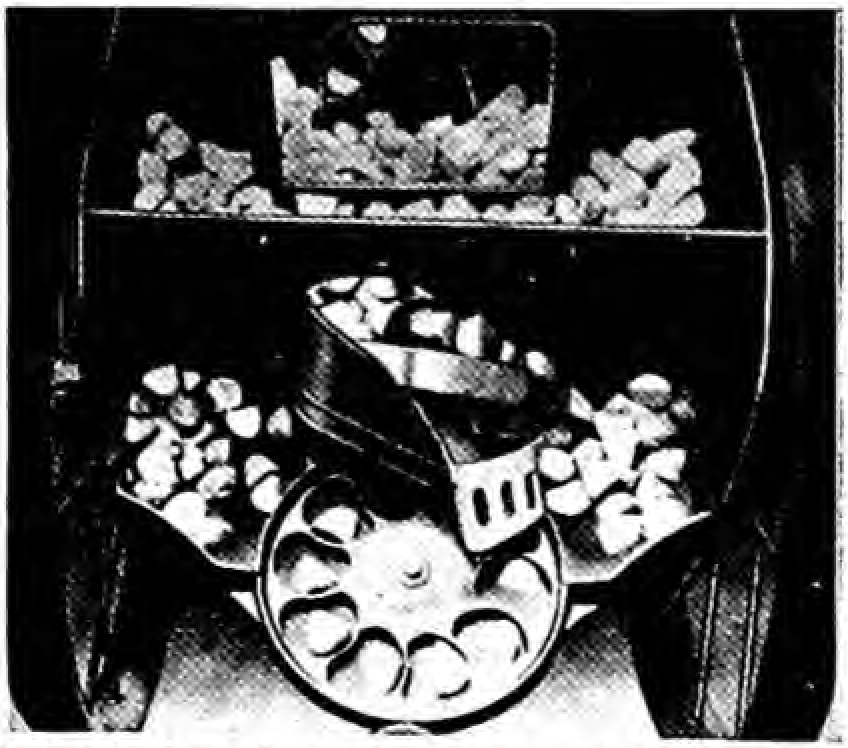


FIG. 306.—Assist feed mechanism of the semiautomatic potato planter.

279. The Semiautomatic Planter.—The dropping mechanism for this type of planter is entirely different from that of the automatic type. The seed drops from an elevator wheel through a feed spout into the

pockets of a revolving horizontal feed ring (Fig. 306), which carries the seed around to the opening over the seed spout through which it falls into the furrow. Should the elevator fail to place a seed piece in each pocket of the feed ring, it is the duty of the man on the planter to fill

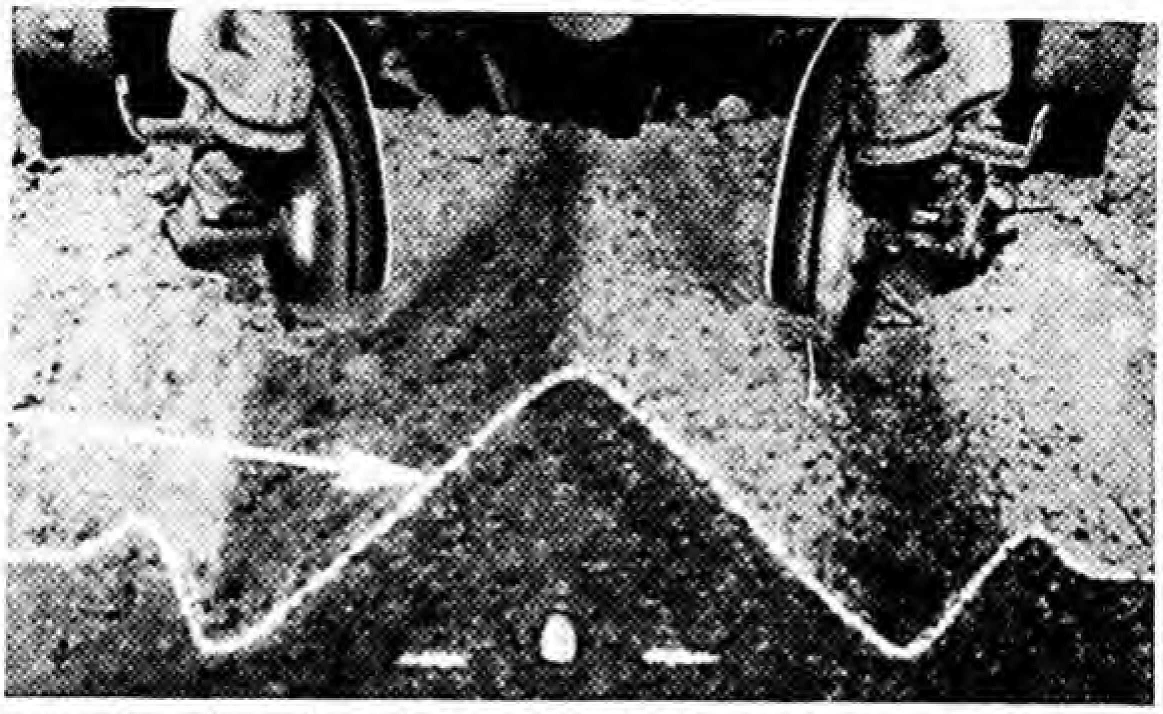


FIG. 307.—Showing location of seed piece in relation to bands of fertilizer and how soil is ridged over them.

the pocket. For this reason this type of dropping mechanism is sometimes called an *assist feed mechanism.* If two pieces are placed in one pocket the man can remove one of them. Spacing of seed is done by changing the feed rings. Feeds may have ten, twelve, fifteen, or eighteen pockets.

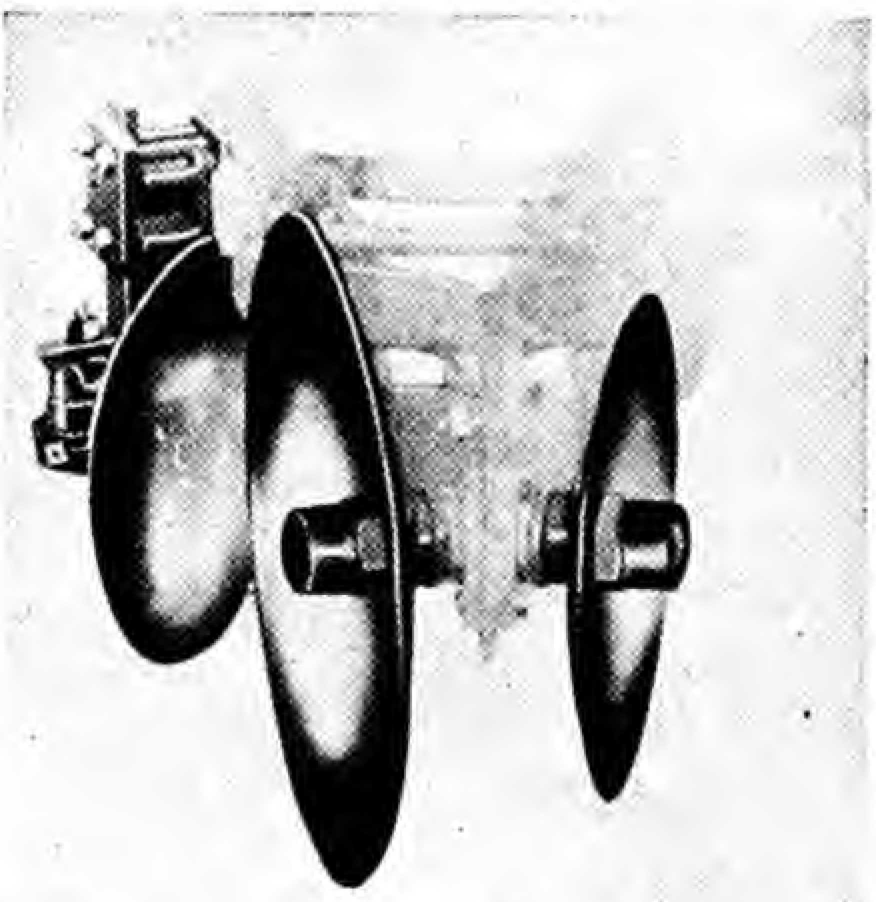


FIG. 308.—Small and large opener disks to place fertilizer at high and low depth.

280. Attachments for Potato Planters.—The soil of some potato-growing areas is low in fertility, and fertilizer attachments are used in combination with the planter to save the cost of a separate operation to apply the fertilizer. The potato is easily injured if it comes in contact

with fertilizer, and for this reason the fertilizer is placed in bands to each side of and below the level of the seed (Fig. 307). Double-disk fertilizer openers have a 12-inch disk on one side to place the fertilizer about seed level and a larger disk on the other side to place the fertilizer deeper or lower in the soil (Fig. 308). This method of applying fertilizer is called *hi-lo* (high-low) *application* (Fig. 291).

Stub-runner furrow openers are usually used on potato planters, but single- or double-disk openers can be obtained.

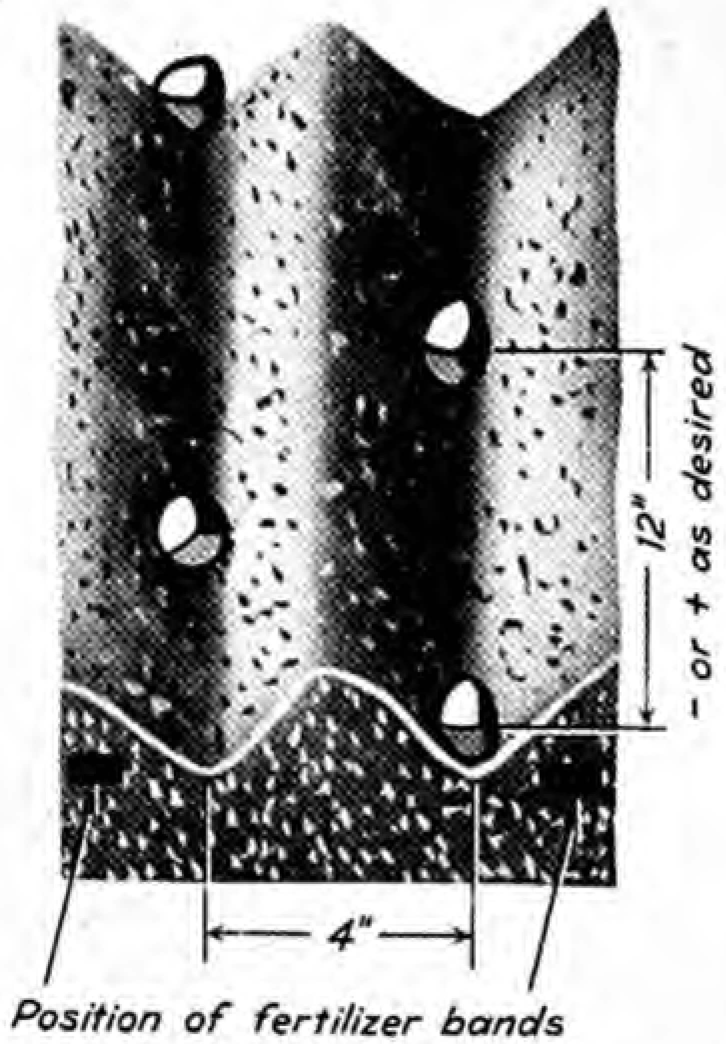


FIG. 309.—Potatoes can be planted in twin rows.

Disks are used to cover and ridge the soil over the seed.

Either the shoe or disk type of row marker can be obtained.

A double spout is available for placing the seed in twin rows (Fig. 309). Tractor-drawn potato planters are made in one-, two-, and four-row sizes. The width between rows on the two-row planter can be adjusted for spacings ranging from 30 to 42 inches at 2-inch intervals.

TRANSPLANTING MACHINES

Where large quantities of plants, such as cabbage and sweet potatoes, are to be transplanted, time and labor can be saved by the use of a transplanting machine (Fig. 310). These machines have a device to

open a small furrow, a tank for the supply of water, a hopper for fertilizer, and disks or blades for closing the soil over the fertilizer and about the plants. With a transplanting machine it is not necessary to wait for a season, because the machine automatically pours a small quantity

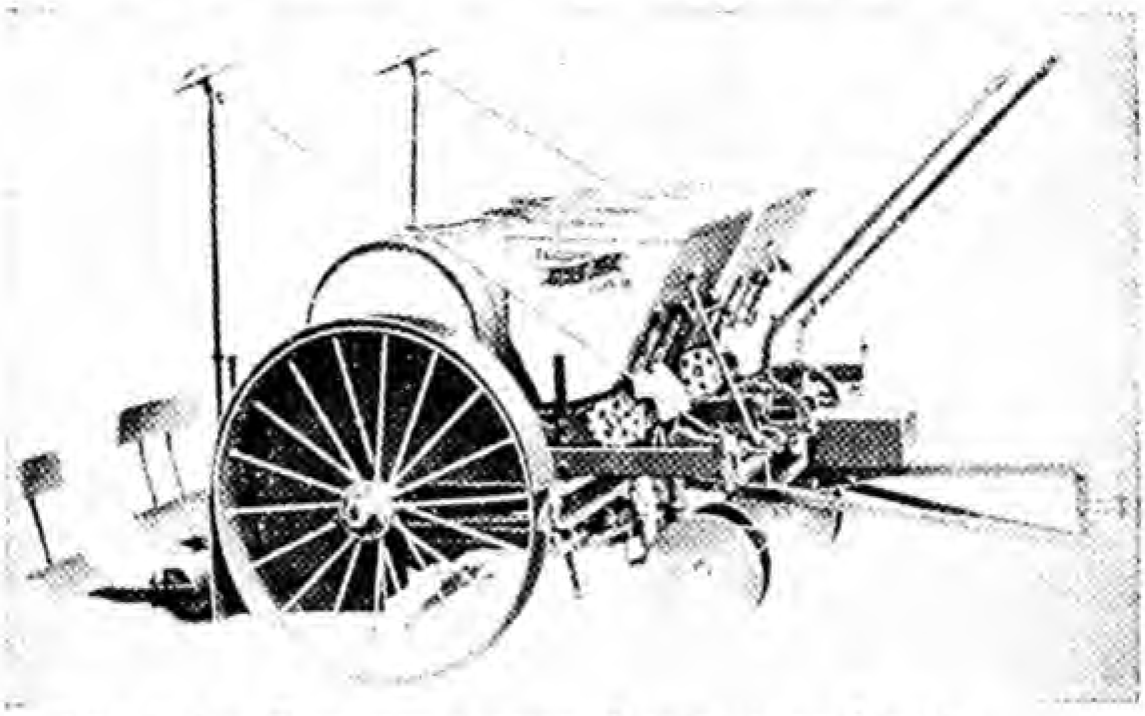


FIG. 310.—Two-row tractor-drawn transplanter.

of water around the roots of each plant as it is being set. Under favorable conditions with a one-row machine 3 to 8 acres of land can be set to plants per day. Twice as much can be done with a two-row machine, or 6 to 16 acres per day.

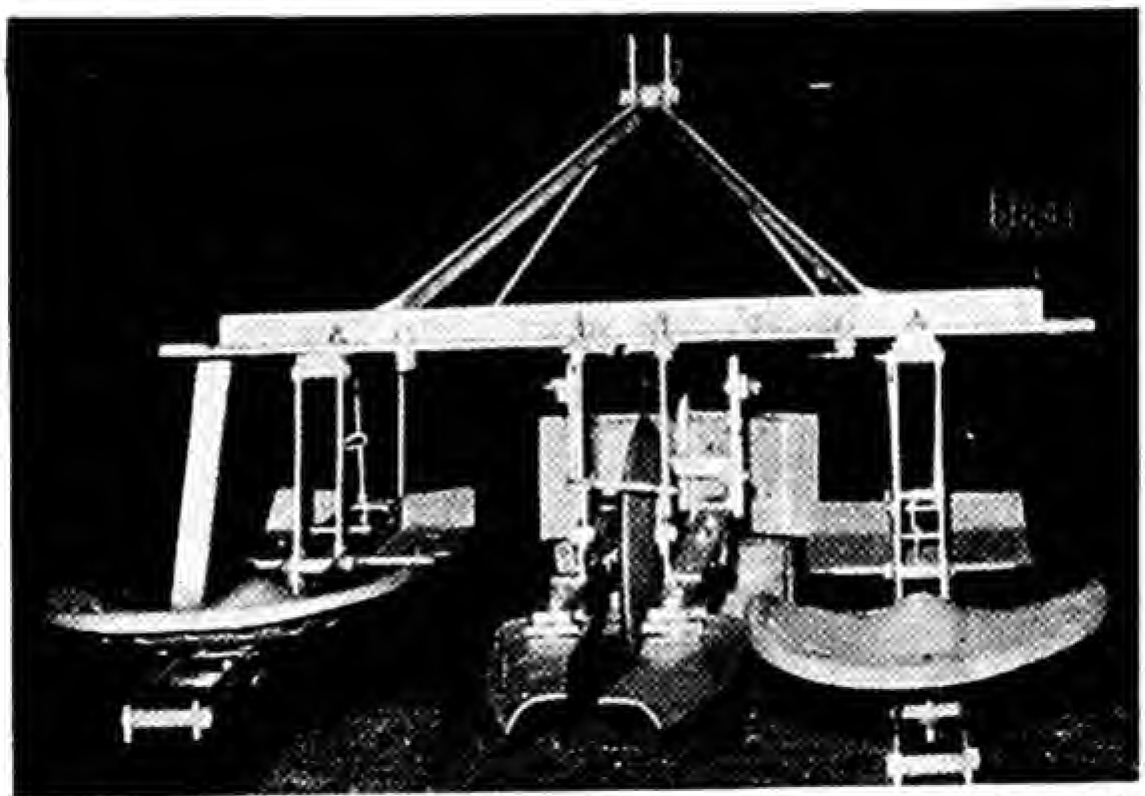


FIG. 311.—Homemade one-row tractor-mounted transplanter for the setting out of sweet-potato slips.

Figure 311 shows a homemade one-row tractor-mounted transplanter for setting out sweet-potato slips. No water is used, as the soil is packed tightly about the potato slips.

CHAPTER XVII

SEEDING MACHINERY FOR SMALL GRAINS AND GRASSES

Machinery for planting small grains and grasses can be divided into two classes, broadcast seeders and drills. Seeding by drill differs from broadcast seeding in that the drill places the seed in the ground at a definite depth and in narrowly spaced rows, while the broadcast seeder scatters the seed over the surface of the ground. There are several types and sizes of drills and broadcast seeders to meet the needs of farmers in different areas.

BROADCAST SEEDERS

Broadcasting is the oldest and simplest method of sowing seed. When the sower went forth to sow, in the time of our Saviour, he carried

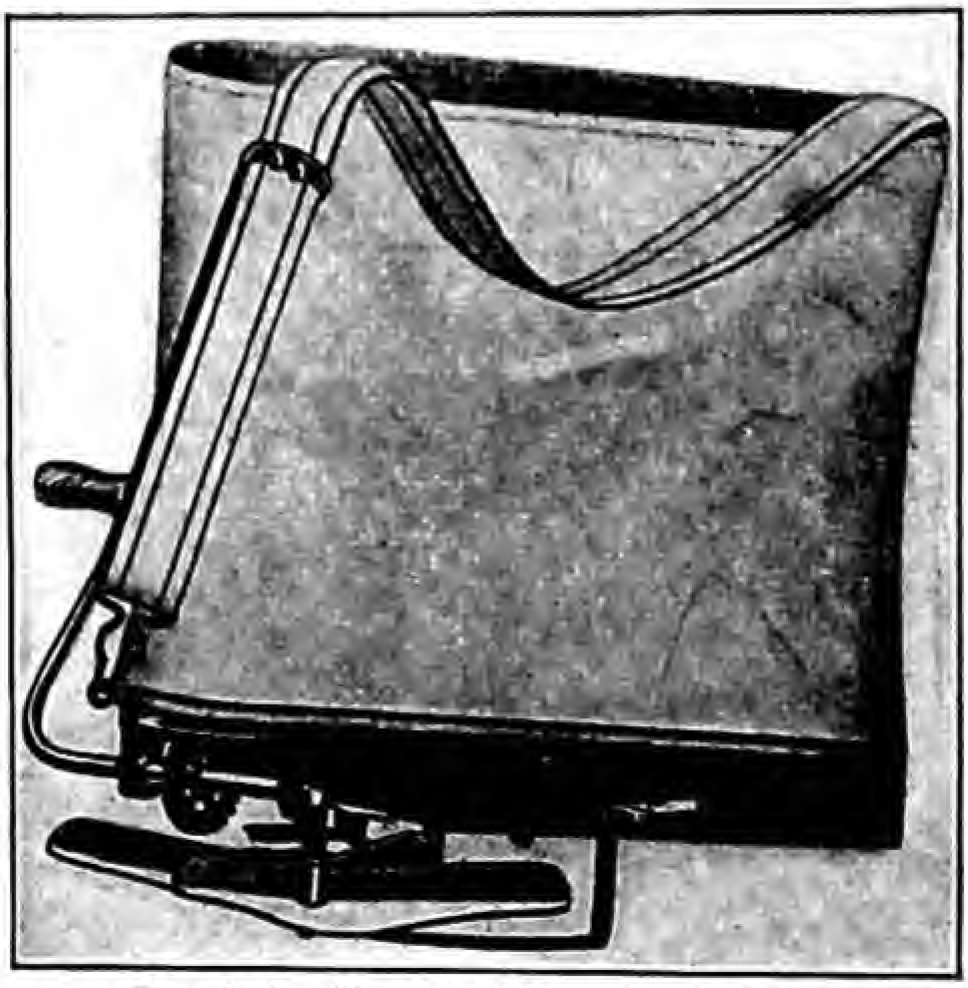


FIG. 312.—Knapsack broadcast seeder.

seed in a bag and broadcast them by hand. Broadcasting with a machine is more accurate and rapid than when done by hand. Types of machine broadcasters are the knapsack, end-gate, two-wheel, and wheelbarrow. Broadcast seeders drop the seed on the surface of the soil and do not have any covering attachments. If covering is desired the seeds are usually covered by harrowing.

281. Knapsack.—This seeder consists of a good-sized canvas sack fastened to a seeding mechanism, the whole being slung over the shoulders (Fig. 312). A crank turned by hand revolves a wheel having several different radial ribs for scattering the seeds. The ribs throw the seeds out to the front and sides in a steady stream. The quantity of seed is regulated by a sliding gate. The wider the gate is opened, the more seed per acre will be sown. This type of seeder is good for sowing clover seed and small grass seed on lawns and fields in the early spring. Other types of knapsack seeders may have the wheel for scattering the seed placed in a vertical plane in front of the seeder. Still others, instead of having one wheel placed in a horizontal plane, may have two wheels, turning in opposite directions, placed opposite each other. The seeds are dropped on the inner sides and thrown to the front and sides.

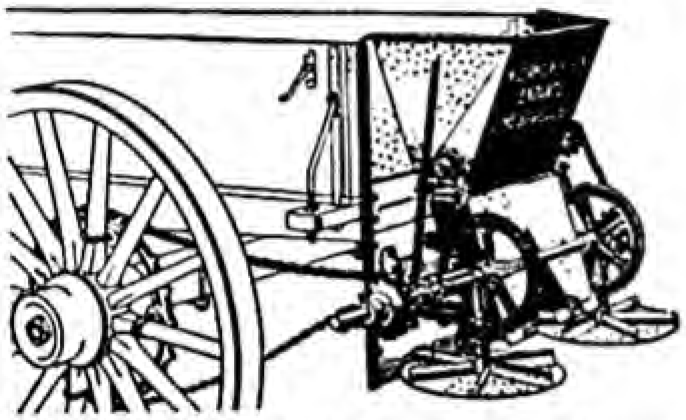


FIG. 313.—End-gate broadcast seeder.

282. End-gate Seeder.—The end-gate broadcast seeder is an attachment that is placed on the rear end of a wagon box (Fig. 313). It consists of a hopper, a feeding device, and either one or two distributing wheels. These radial-ribbed distributing wheels are driven by a chain and sprocket, receiving their power from the left rear wheel of the wagon.

283. Two-wheel Horse-drawn Broadcast Seeder.—There are two types of two-wheel horse-drawn broadcast seeders, the narrow-track and the wide-track (Fig. 314). It is claimed that the narrow-track seeder (Fig. 315) is more practical where covering devices are not used. It also eliminates whipping of the tongue on rough ground.

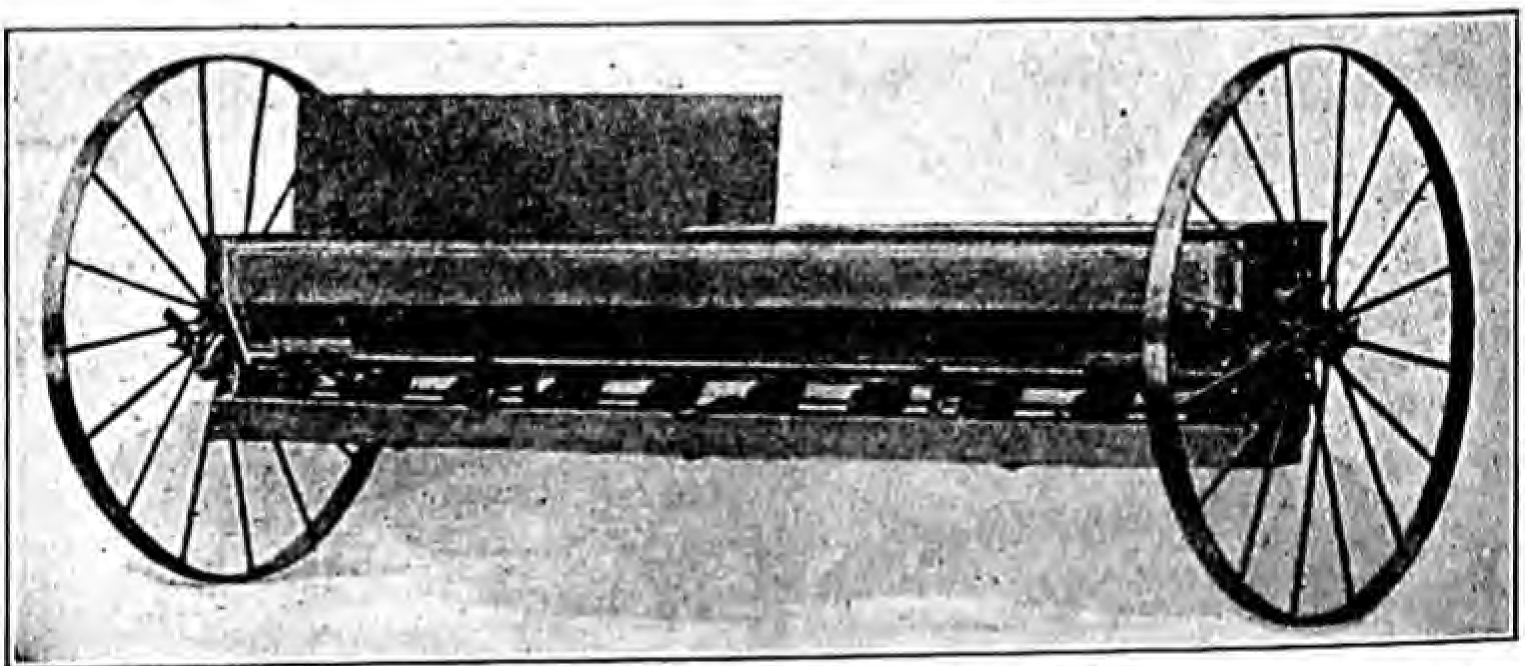


FIG. 314.—Wide-track broadcast seeder.

Both types use the fluted-wheel type of feed. The narrow-track broadcast seeder has grain spouts hinged to the seed cups and held in

position by a stout coil spring. If a spout should strike a stump or other obstruction, it will swing back out of the way and then return to position.

Markers are provided at each end of the hopper on the narrow-track broadcast seeders. Markers are not necessary on the wide-track broadcast seeders because the wheels leave a track which serves as a guide. Where it is desirable to cover the seed, two-wheel wide-track broadcasters can be obtained with hoe-type coverers. Seed boxes are available for mounting on disk harrows and one-way disk plows.

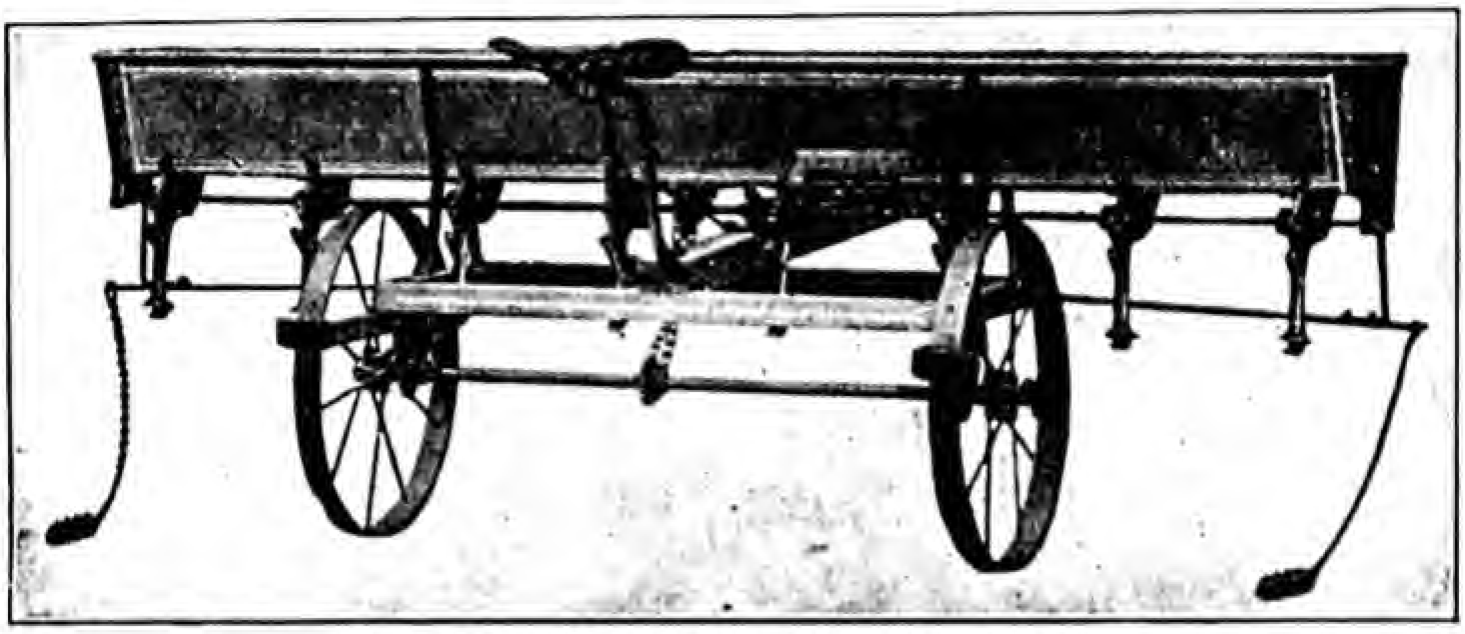


FIG. 315.—Narrow-track broadcast seeder.

284. Wheelbarrow Broadcast Seeders.—The wheelbarrow broadcast seeder is composed of a wheelbarrow frame with a long seed box mounted on the front end. This box is about 3 inches square and about 8 to 16 feet in length.

285. The Airplane as a Broadcast Seeder.—The airplane has been used quite successfully for the sowing of clover seeds over pastures and rice where the fields are soft or flooded with water. A special hopper with a wind-driven feed at the bottom is installed in the fuselage of the plane. The seed are fed into a venturi tube, the rear end of which is divided into sections so that the seed are spread more uniformly.

GRAIN DRILLS

The grain drill is a machine designed and built to place the seed of small grains and grasses in the ground in rows at a uniform depth. The principal parts are the main frame, transport and drive wheels, a box for the seed, a device to feed the seed out of the hopper in uniform quantities, furrow openers to open furrows for the seed, and covering devices.

Grain drills can be classified as *plain drills* and *fertilizer drills*. A plain drill has a hopper and feeds for the drilling of seeds only, while the fertilizer drill has a large seed box which is divided lengthwise into two compartments, one for seed and one for fertilizer. The fluted force feed and the double-run feed are used on both the plain and fertilizer drills.

286. Frame.—The frame is usually made of angle steel, well braced and reinforced at the corners. It is necessary that the frame be strong enough to prevent sagging and to hold the parts in alignment, as all parts are connected to the frame. The axle is carried beneath, with the

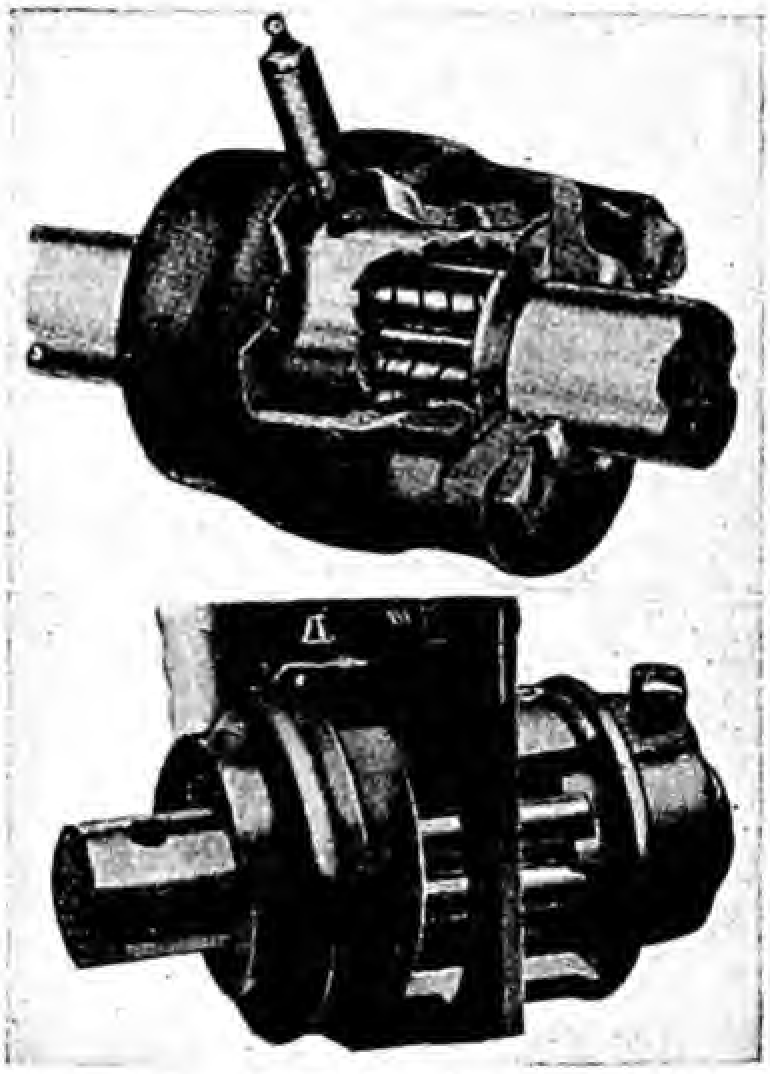


Fig. 316.—Bearings for grain drill.

wheels on each end of it. The seed box is carried above, while the furrow openers are suspended below. Roller bearings are usually used on each end of the axle (Fig. 316).

287. Wheels.—The wheels found on grain drills are made of steel. The tires on steel wheels are usually concave in shape to prevent slipping

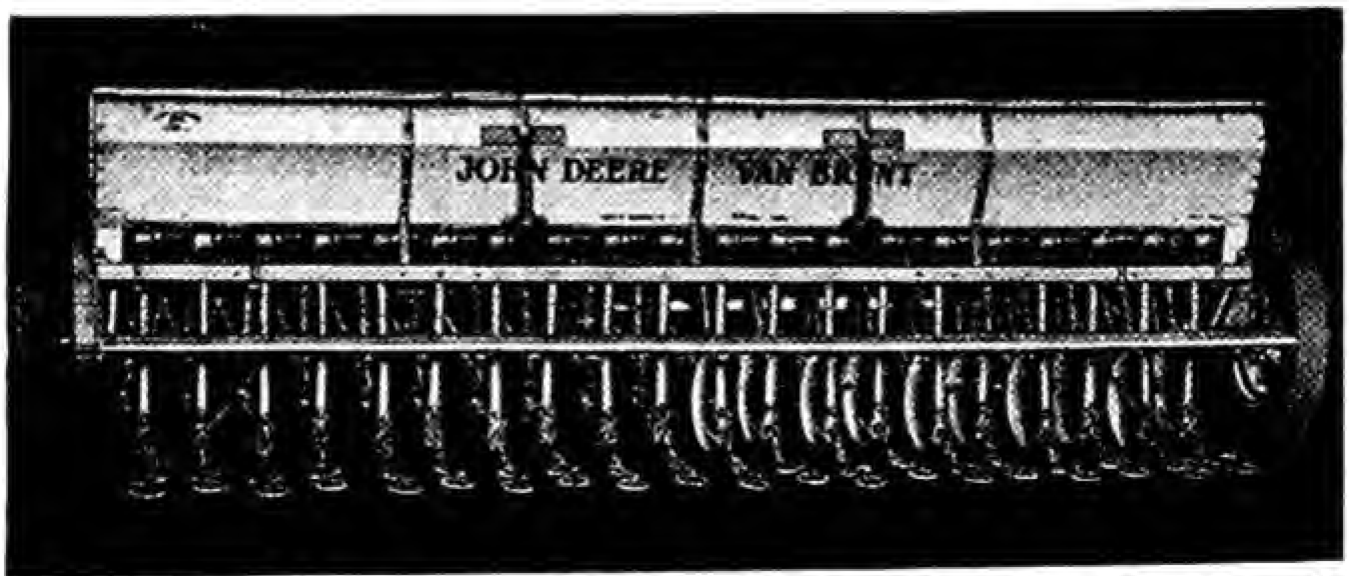


Fig. 317.—Rear view of a 20 by 7 grain drill equipped with pneumatic rubber-tired wheels.

on sloping land. Drills also can be obtained equipped with pneumatic rubber-tired wheels (Fig. 317).

In the hubs of the wheels are ratchets and pawls to afford a means of transmitting the power from the hub of the wheel to the axle and, at

the same time, allow turning where it is necessary that one wheel remain stationary and the other turn. It is essential that the pawls engage the ratchet immediately after the grain drill is moved forward. If the wheels can be revolved any distance without the pawls engaging immediately, bare strips will be left in the field.

FIG. 318.—Steel seed box for grain drills.

288. Seed Box.—The seed box should be well braced and built rigid. The end of the box is shaped somewhat similar to a trapezoid (Fig. 318). The box tapers from the top, allowing the seed to flow directly

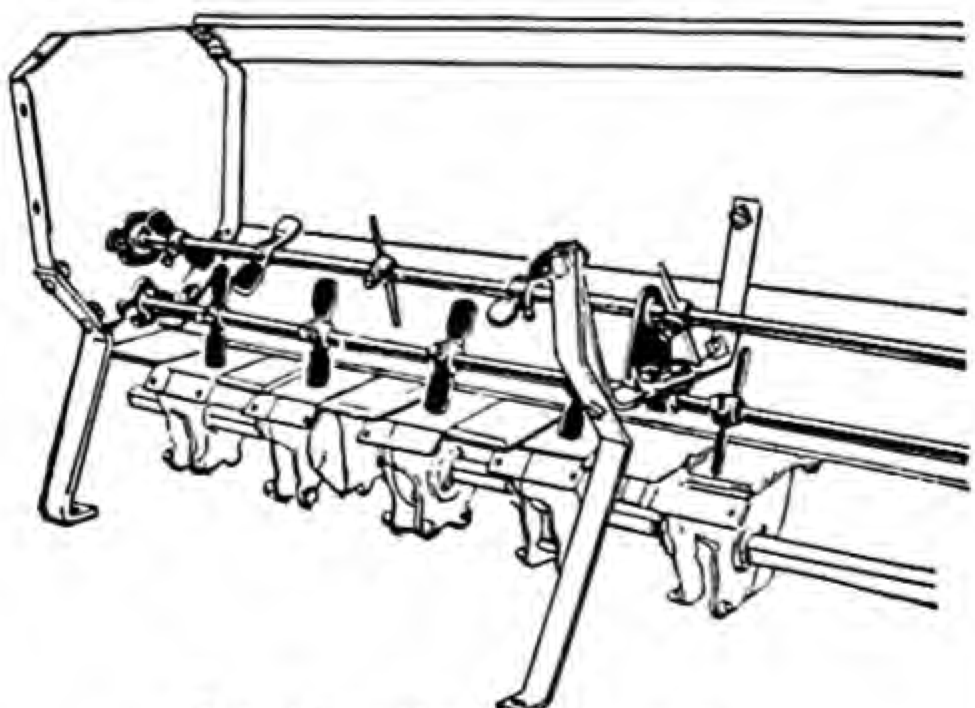


FIG. 319.—Double-rod agitator.

into the feed cup. Agitators are provided to prevent the grain *bridging over* in the box. They may be single or double rods. Figure 319 shows a double-rod agitator. The grain feeds are in the bottom of the box.

There are two types of grain feeds, the fluted-wheel and the double-run feed.

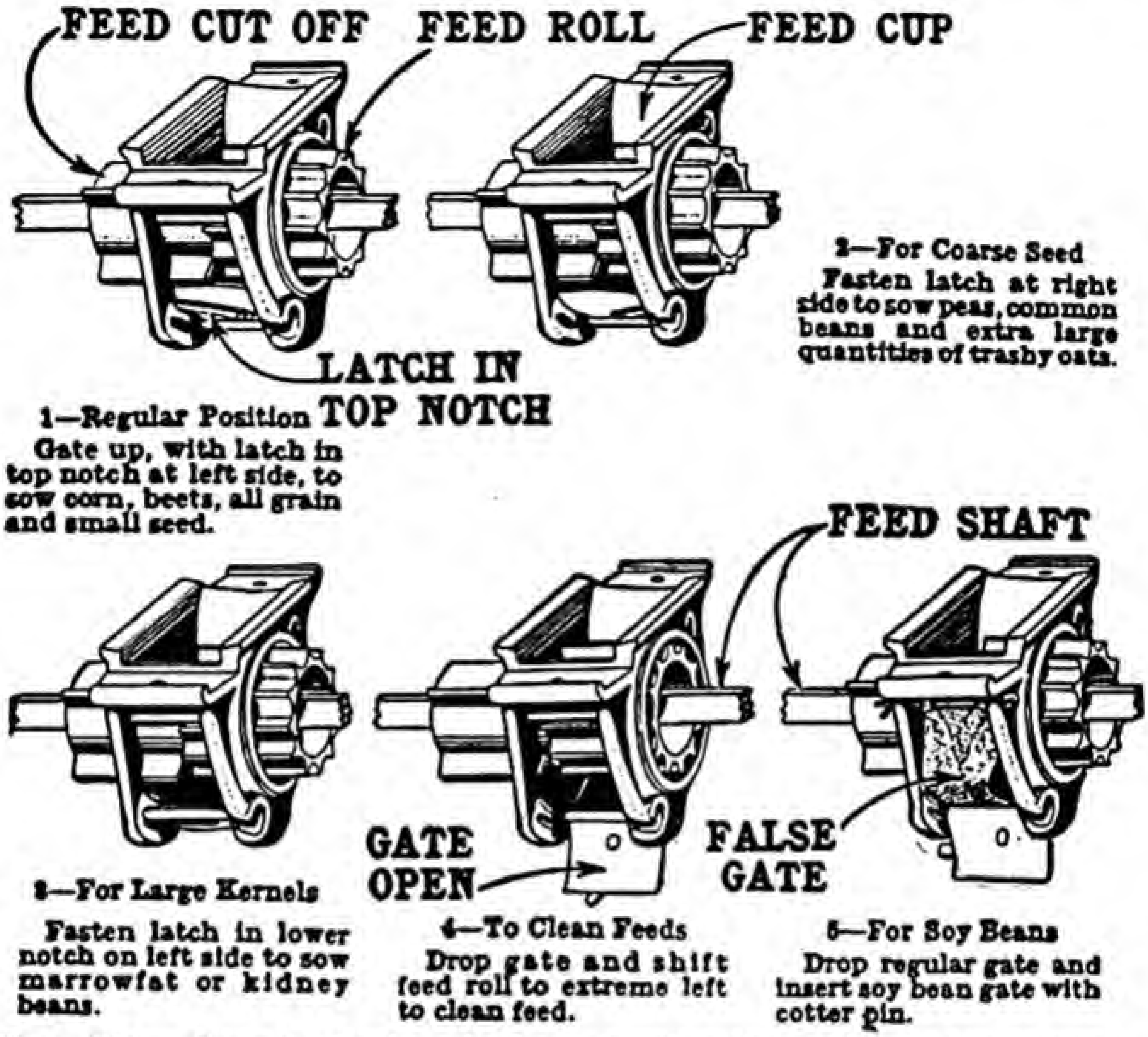


FIG. 320.—Fluted-wheel grain feed showing the various adjustments.

289. The Fluted-wheel Feed.—The fluted-wheel feed is considered the simpler of the two. It is also more generally used. It has a greater number of seeding rate settings and is easier to clean than the double-run feed. It consists mainly of a fluted-wheel feed roll, feed cut-off, and an adjustable gate. Figure 320 shows that the feed roll and the cut-off are mounted on a square shaft running through the feed cups. The feed roll turns with the shaft, forcing the grain out over the gate, where it falls into the seed tube. The gate is adjustable for different-sized seeds.

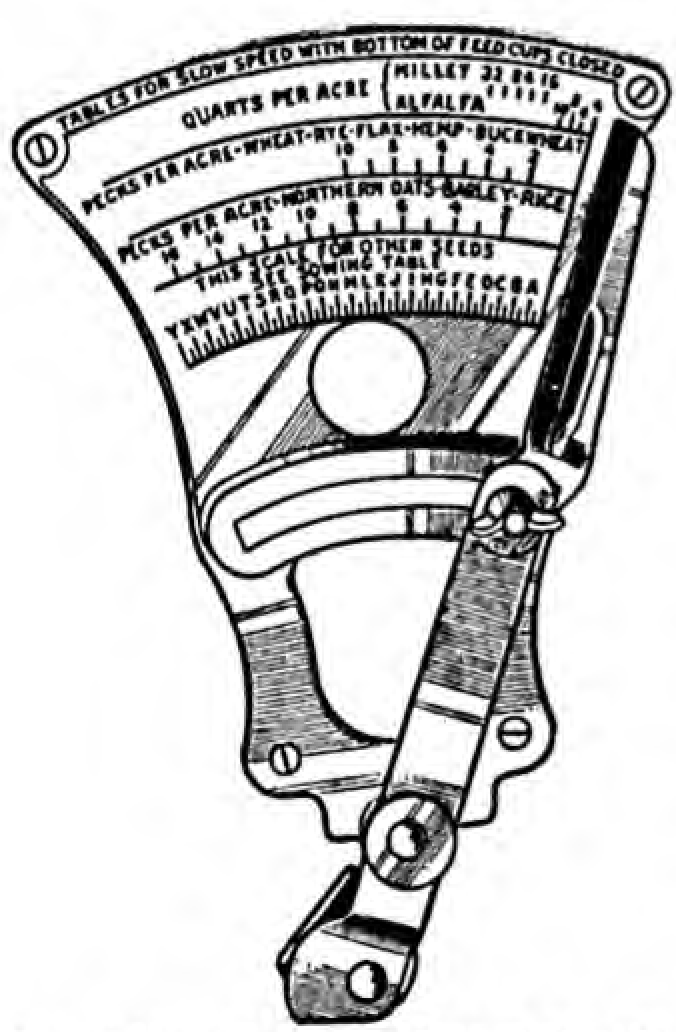


FIG. 321.—Quantity-feed dial indicator for fluted-wheel grain feed.

Power is transmitted from the main axle to the feed shaft by gears or sprockets and chains.

The quantity of seed sown per acre is varied by exposing more or less of the feed roll to the seed inside the feed cup and by adjusting the gate. Figure

321 shows a typical indicator plate used to adjust the fluted feed roll to sow the desired quantity per acre. The various adjustments of the fluted wheel are shown in Fig. 320.

290. The Internal Double-run Feed.—This feed, shown in Fig. 322, gets its name from its construction. It consists of a double-faced wheel having a small and a large side. The small side is used for planting

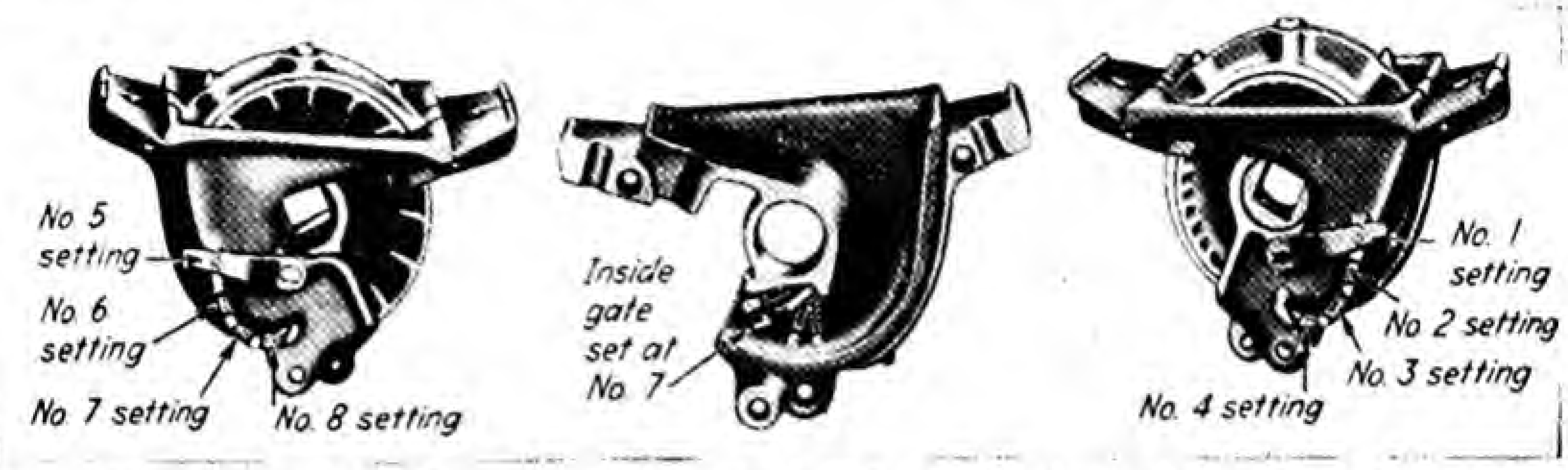


FIG. 322.—Internal double-run type of grain-drill feed, showing gate positions for seeding rate.

small seeds, while the large side is used for planting larger seeds such as oats, wheat, peas, and beans. Figure 322 shows one side covered while the other is in use. The lid is hinged over the middle of the wheel so it can be reversed to cover either side.

The quantity of seed sown per acre is changed by varying the speed of the feed wheels. Figure 323 shows an arrangement for changing the

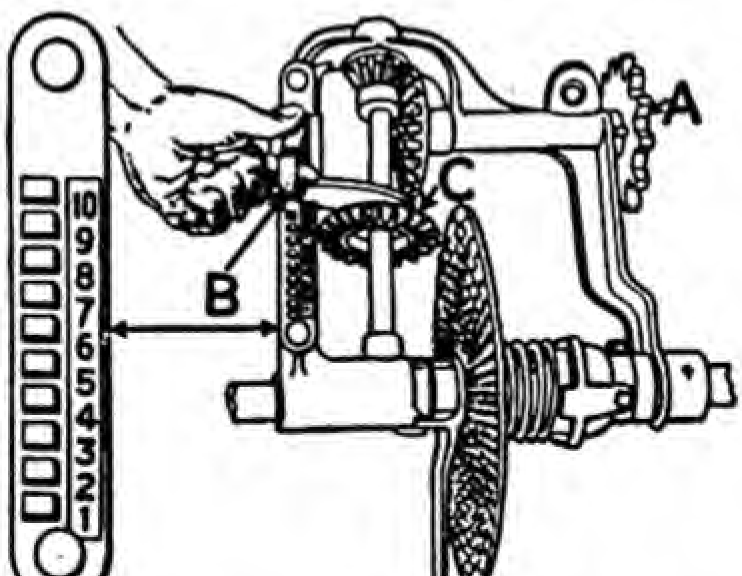
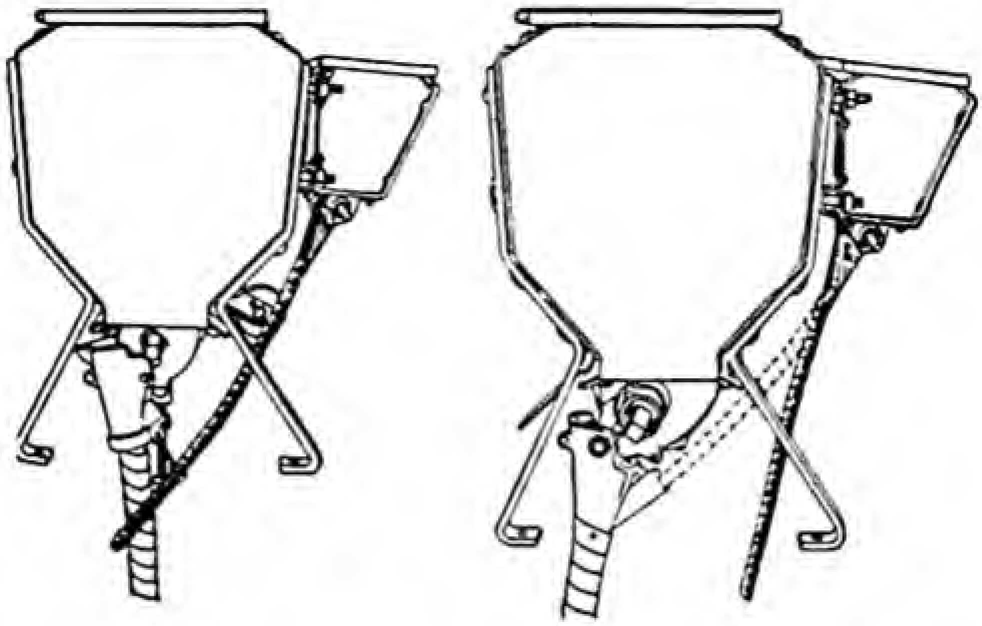


FIG. 323.—Method of varying the quantity of seed sown per acre with the internal double-run feed.

speed. Special attachments to reduce the size of the outlets and adjustable gates also aid in regulating the quantity of seed sown per acre.

291. Seed Tubes.—Seed tubes are provided to conduct the seed from the feed cup down through the boot and furrow opener into the furrow.

The most common type of seed tube is the steel ribbon shown in Fig. 324. Being rolled with the lower edge slightly thinner than the upper edge makes the tube collapsible to half its normal length without



A B

Fig. 324.—Seed box showing grass-seed attachment: *A*, shows grass-seed tube arranged to sow behind grain; *B*, shows tube for sowing grass seed either ahead of or with the grain

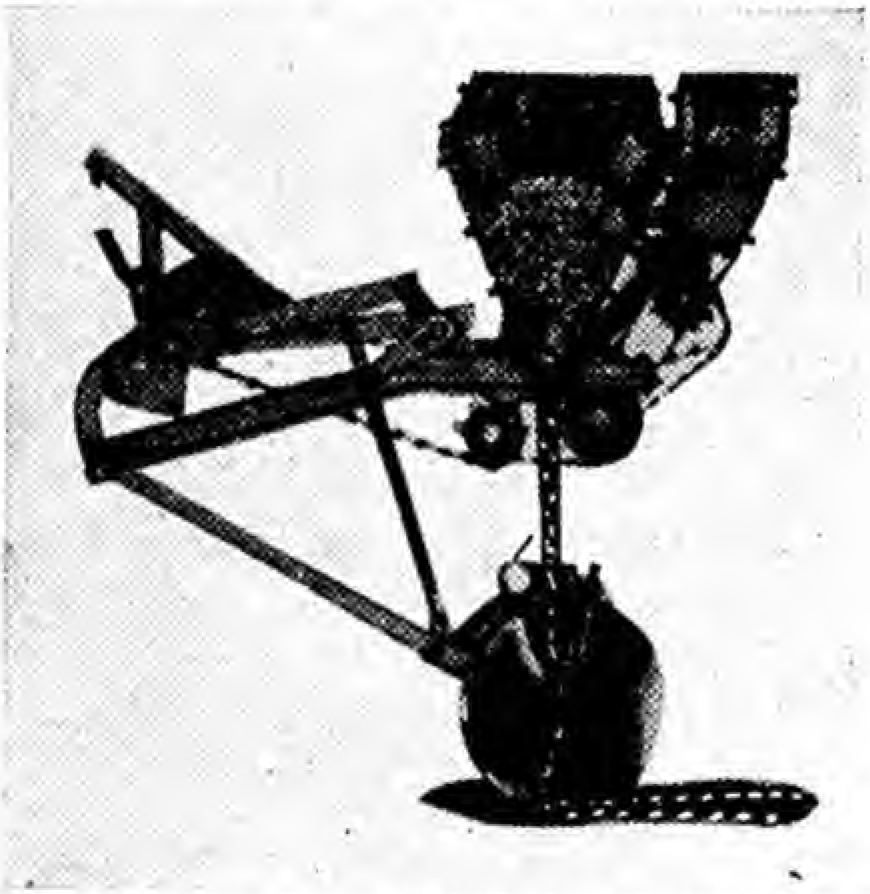


Fig. 325.—Seed and fertilizer being distributed through the same seed tube.

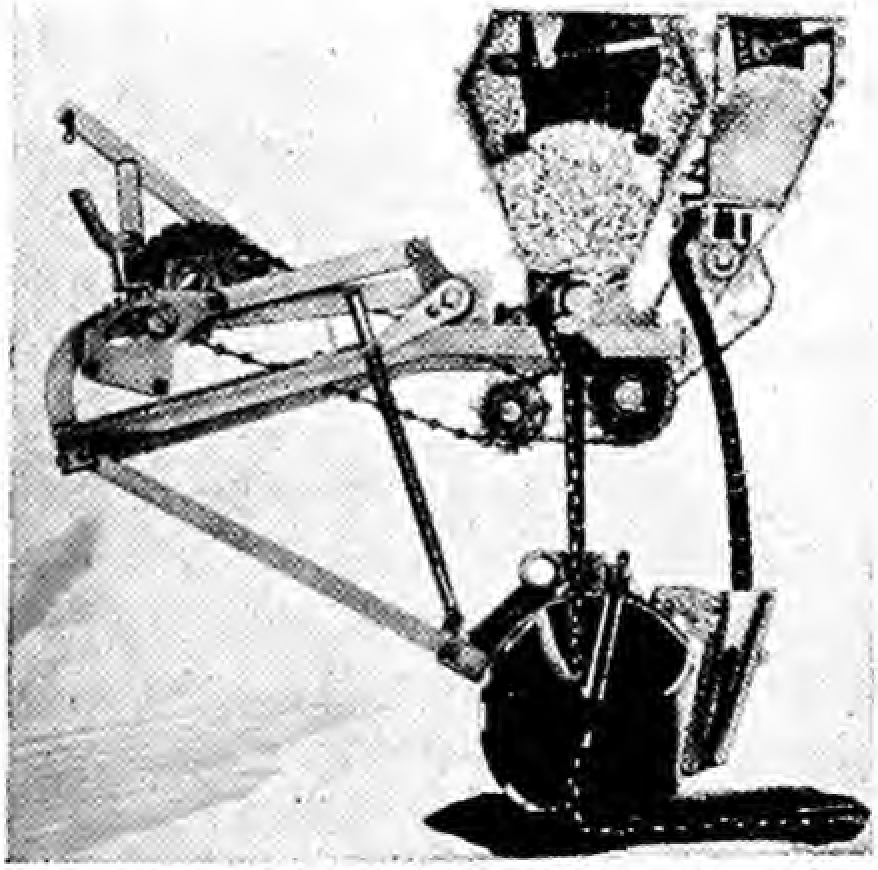


Fig. 326.—Seed and fertilizer being distributed through separate tubes.

diminishing the inside diameter or retarding the even flow of grain through it.

Figure 324 shows how the grass-seed tube is attached to the regular seed tube.

When fertilizer is being distributed it may also pass down the regular grain-seed tube or down a separate tube (Figs. 325 and 326).

292. Boot.—The boot is the hollow casting into which the lower end of the seed tube extends and to which the furrow openers are attached.

293. Furrow Openers.—There are four types of furrow openers used on grain drills: the hoe, shoe, single, and double disk.

The *hoe* furrow opener shown in Fig. 327 consists of a single- or double-pointed shovel fastened to the lower part of the boot. The grain drops into the furrow directly back of the shovel. A spring or pin trip

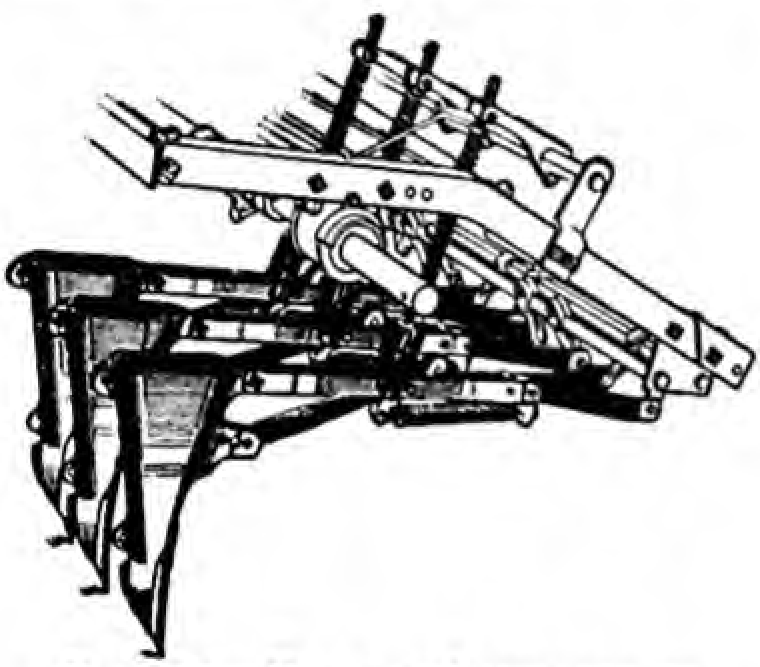


FIG. 327.—Hoe-type furrow opener.

FIG. 328.—Shoe-type furrow opener.

is provided so that, when the hoe strikes an obstruction, no damage is done. This type of opener often gives trouble by clogging up when used in trashy ground.

The *shoe* furrow opener (Fig. 328) is made from two flat pieces of steel welded together to make a cutting edge similar to the curved runner opener used on corn planters.

Single-disk furrow openers consist of one disk slightly dished and securely fastened to the boot and set to run at a slight angle (Fig. 329). The seed are dropped from the boot on the convex side of the disk at a point below and to the rear of the center. A toe scraper is used on the convex side and a tee scraper on the concave side to keep the disk clean. The single-disk opener gives good penetration, cuts trash well, and does not easily clog.

Single-disk semideep furrow openers have 14-inch single disks to open deep furrows in subhumid areas. Half the openers are assembled with the concave side facing the right and half to the left. Penetration is

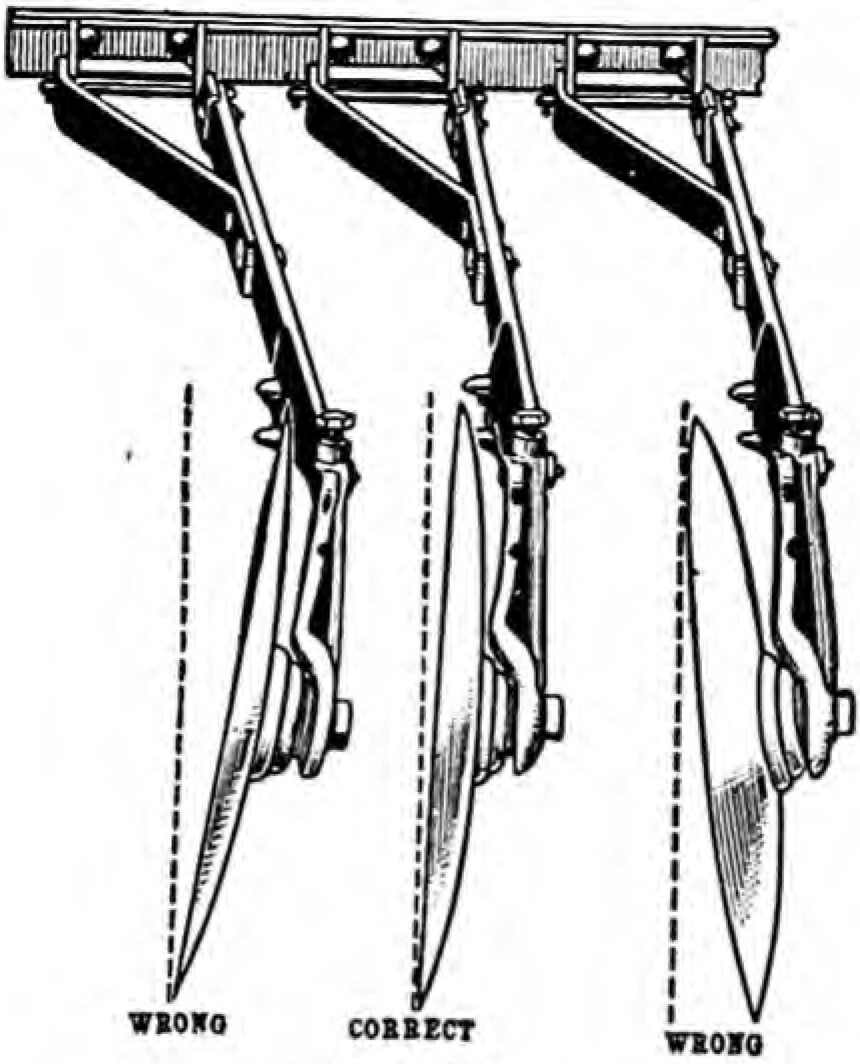


Fig. 329

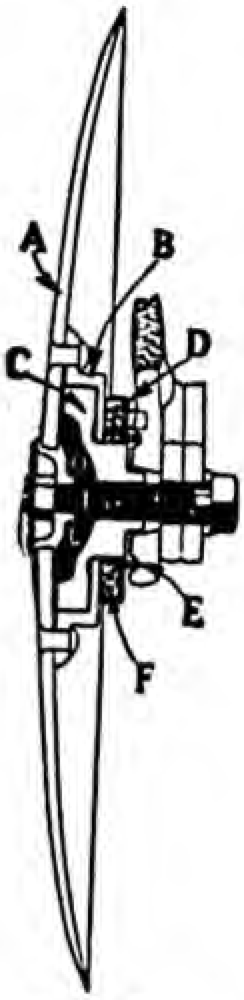


Fig. 330.

Fig. 329.—Single-disk furrow opener.

Fig. 330.—Cross section of drill disk showing bearing: *A*, disk blade; *B*, disk-bearing case; *C*, disk bearing; *D*, felt washer; *E*, steel dust cap; *F*, dust-cap spring.

aided by spring pressure. They may also be set staggered or in a straight line.

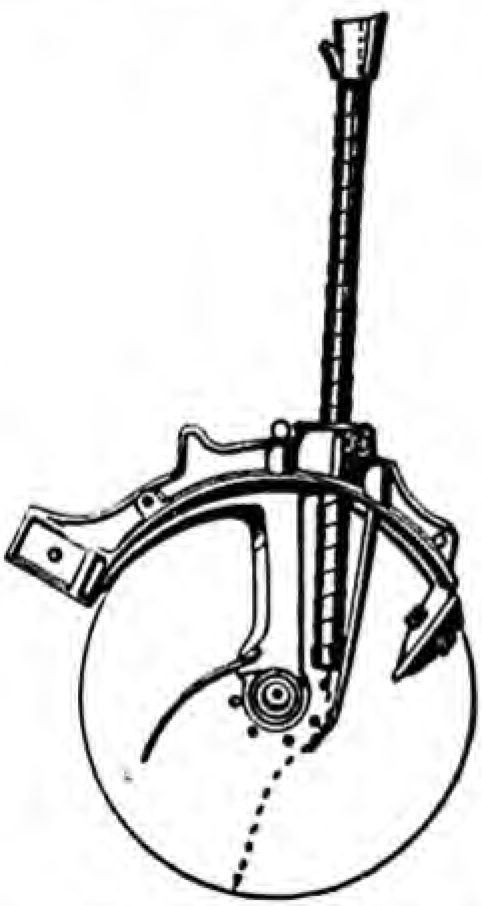


Fig. 331.—View of double-disk opener with one disk removed to show how seed is protected between disk until it reaches the open furrow.

Since the disks revolve, they must be provided with bearings that are well designed, constructed, and lubricated. Figure 330 shows a cross section of the various parts of a well-designed disk bearing.

Figure 329 shows the correct way and the wrong way to set single-disk furrow openers.

A *double-disk* opener is composed of two disks, having very little dish, set facing each other at a slight angle so as to form a bevel cutting edge where they penetrate the soil. In this position the disks open a clean furrow and leave a small ridge in the center so that, when the seed are deposited in the furrow, there is a tendency to make two distinct rows about 1 inch apart. A cutaway view of a double-disk furrow opener is shown in Fig. 331. The seed are protected while passing between the disks until they reach the bottom of the furrow.

Saw-blade double-disk openers are designed to place the seed in the

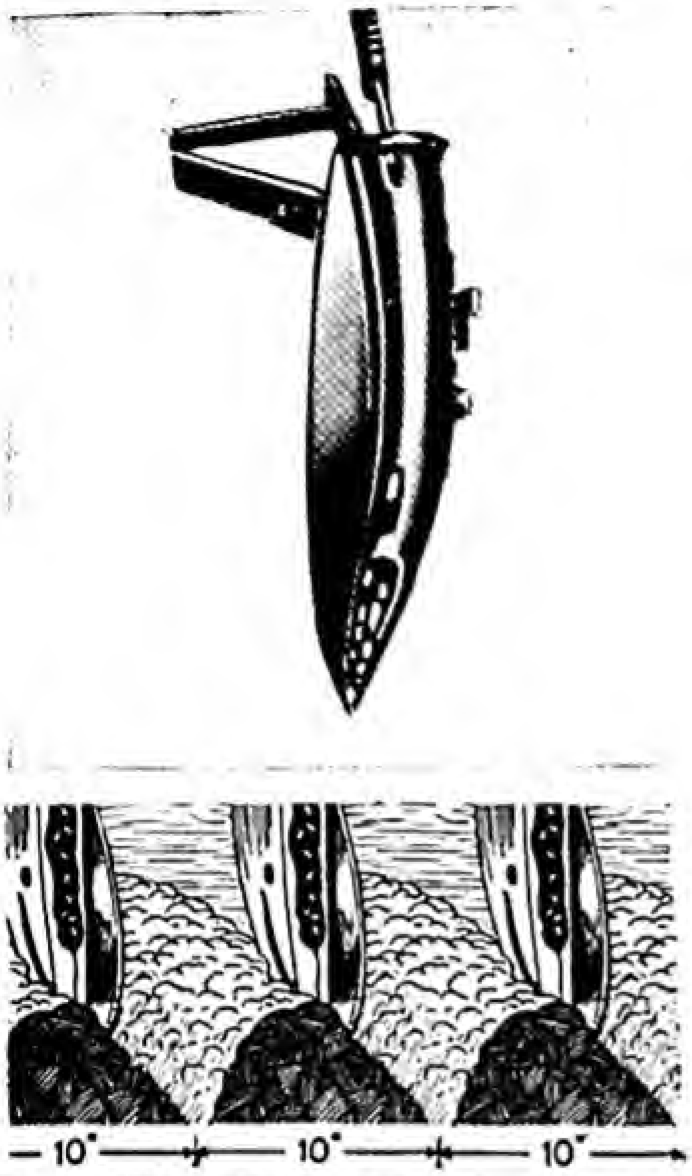


FIG. 332.—Single-disk deep-furrow opener and type of furrow made.

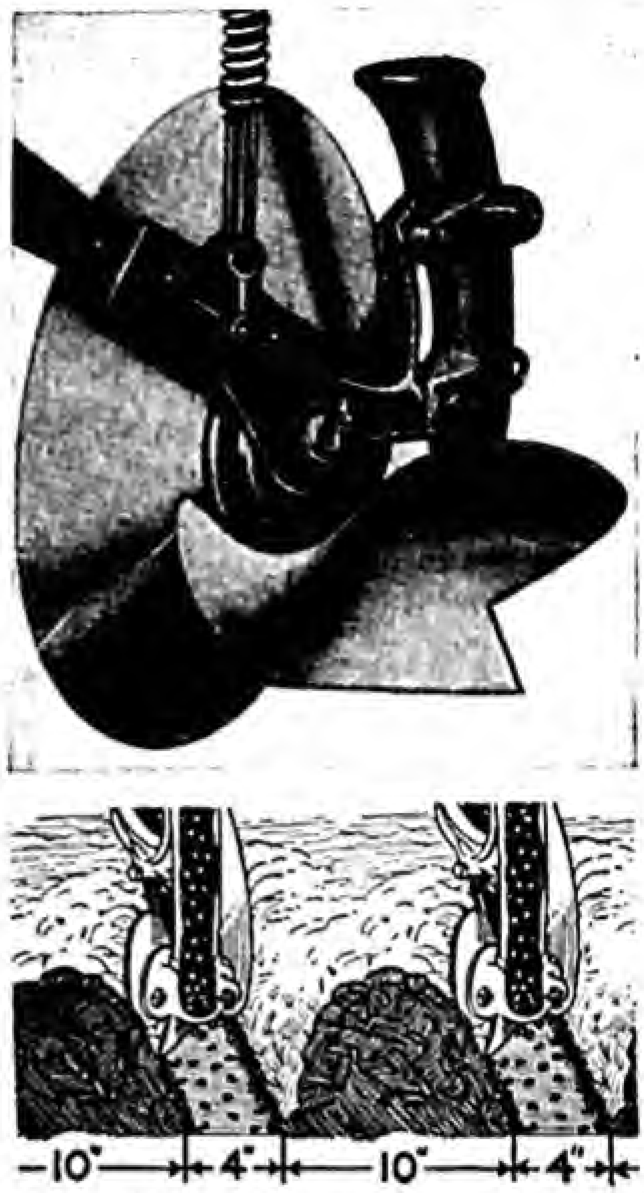


FIG. 333.—New-style lister furrow opener and type of furrow made.

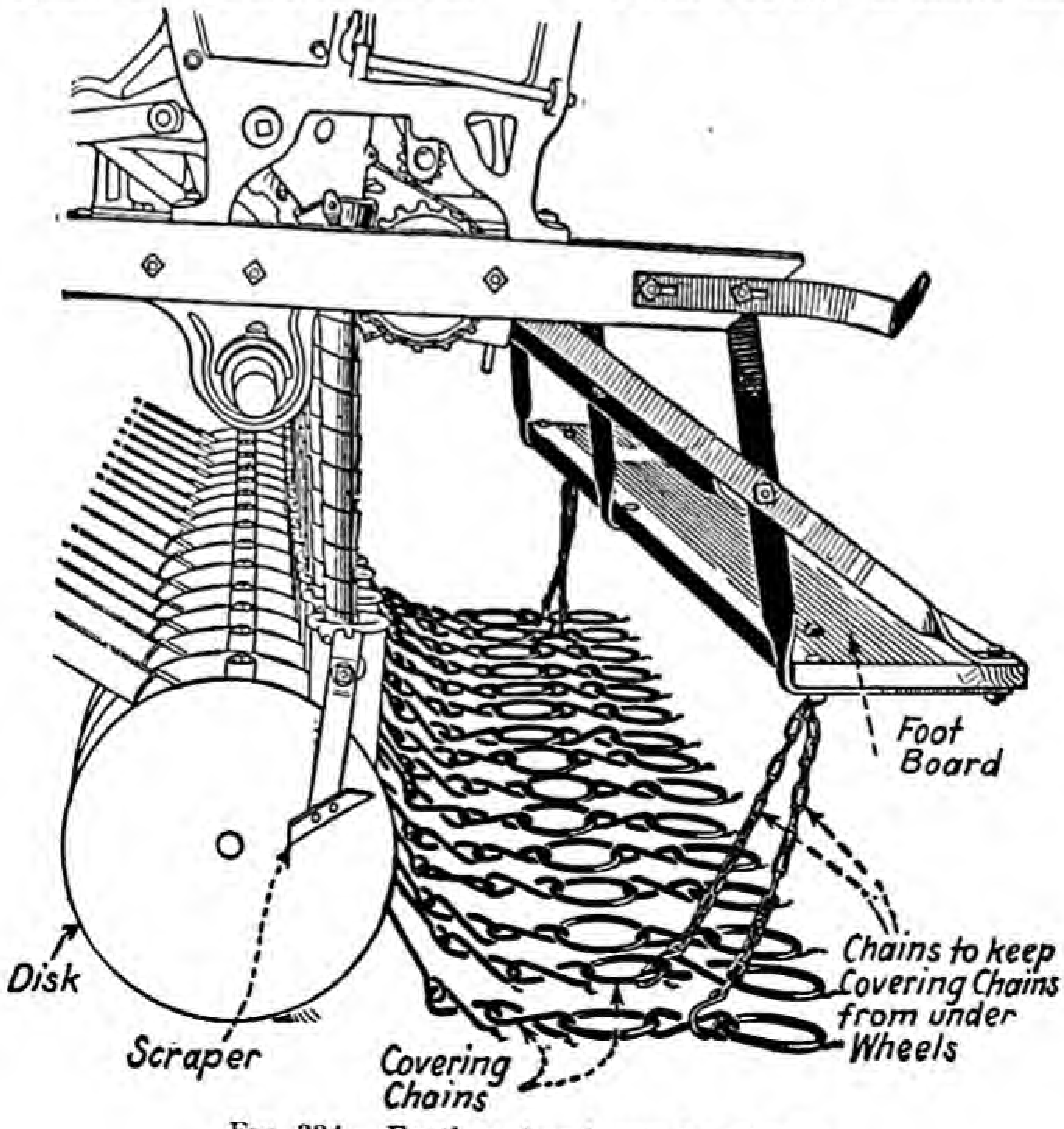


FIG. 334.—Footboard and covering chains.

ground with the downward movement of the disks ahead of the disk axle. This type of opener is suitable for tractor speeds and for trashy land.

Lister or *deep-furrow* openers are shown in Figs. 332 and 333. This type of furrow opener is used to make deep trenches or furrows and ridge the soil so that it will catch snow and moisture and prevent the soil from blowing. The spacing of the openers is wider than that used for the regular grain drill and ranges from 12 to 16 inches between openers.

294. Covering Devices.—The most common type of covering device is the drag chain. Figure 334 shows how it is hooked to the boot and how it drags over the furrows to cover the seed without packing the soil.

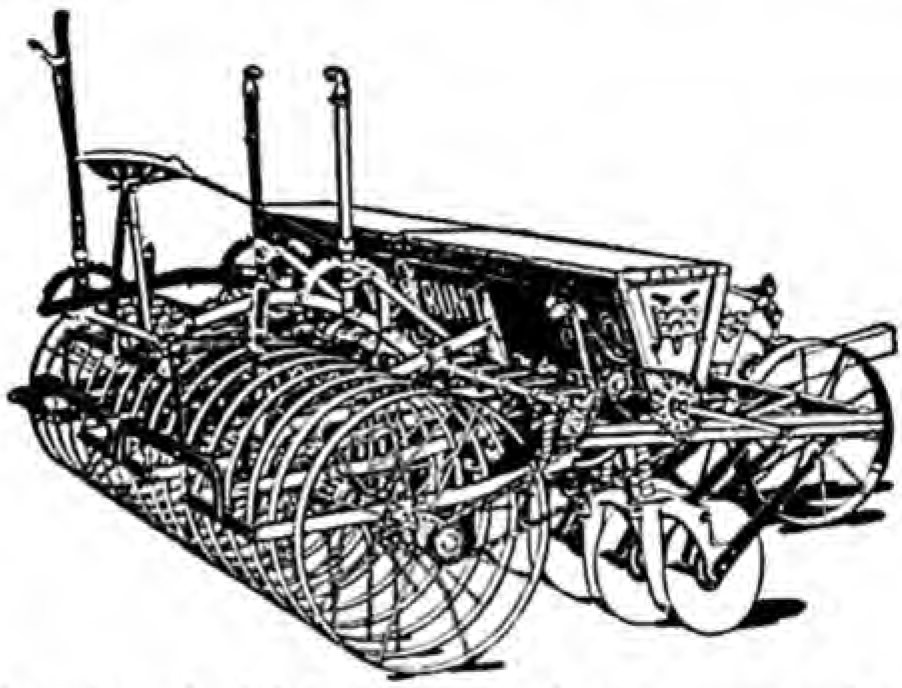


FIG. 335.—Grain drill equipped with large press wheels, grass-seed attachment, and tongue truck.

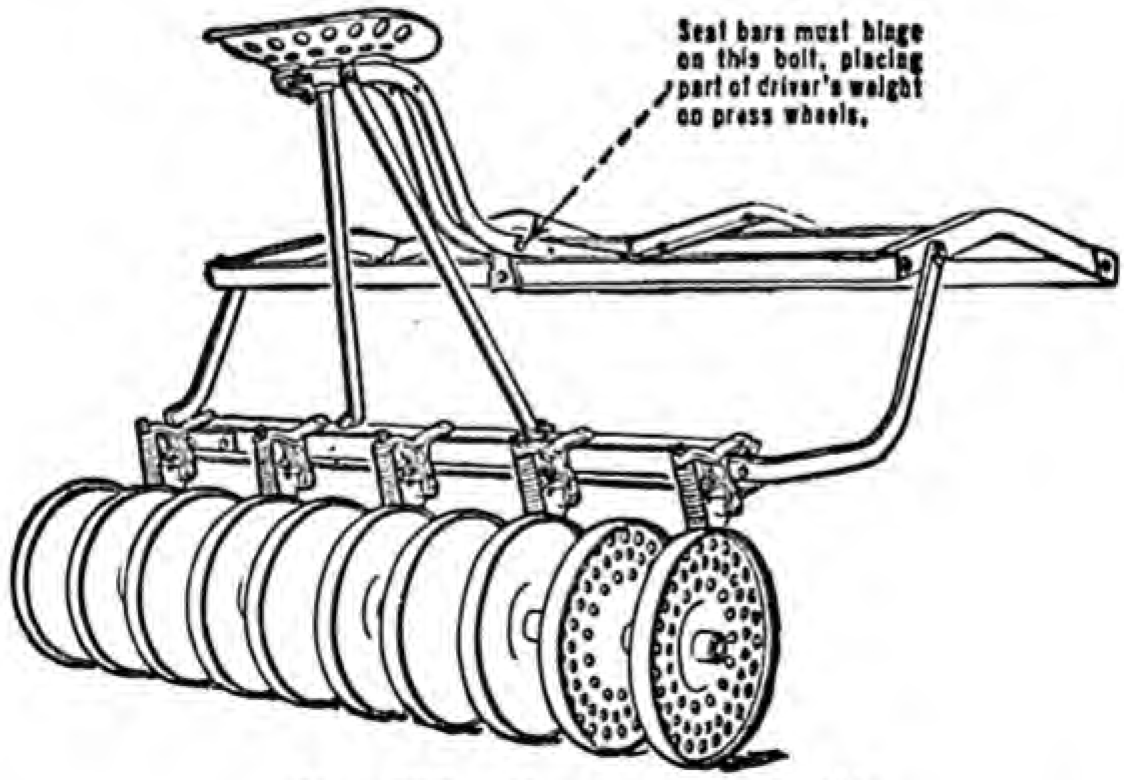


FIG. 336.—Small press wheels.

In the subhumid regions where the soil is dry and likely to blow, press wheels are used to cover the seed and press the soil around them. Figure 335 shows a drill equipped with large press wheels. The regular wheels are replaced by the press wheels. The latter also drive the seeding mechanism. Small gang press wheels (Fig. 336) also may be obtained.

295. Size of Drill.—The size of a grain drill is determined by the number of furrow openers and the distance they are spaced apart. The size is expressed as 18 by 7, which means there are 18 furrow openers spaced 7 inches apart. Drills can be secured with the feeds and furrow openers spaced either 6, 7, or 8 inches apart.

296. Land Measures.—Grain drills are all equipped with a small device, similar to the one shown in Fig. 337, which is called a *land measure* or a *surveyor*. This is an instrument so designed that it determines the number of acres sown. If the operator will keep a record of the number of bushels placed in the seed box and the number of acres sown, a check can be made as to the accuracy of the drill in the amount of seed being sown per acre. This is *not* termed *calibration*, which is described below.

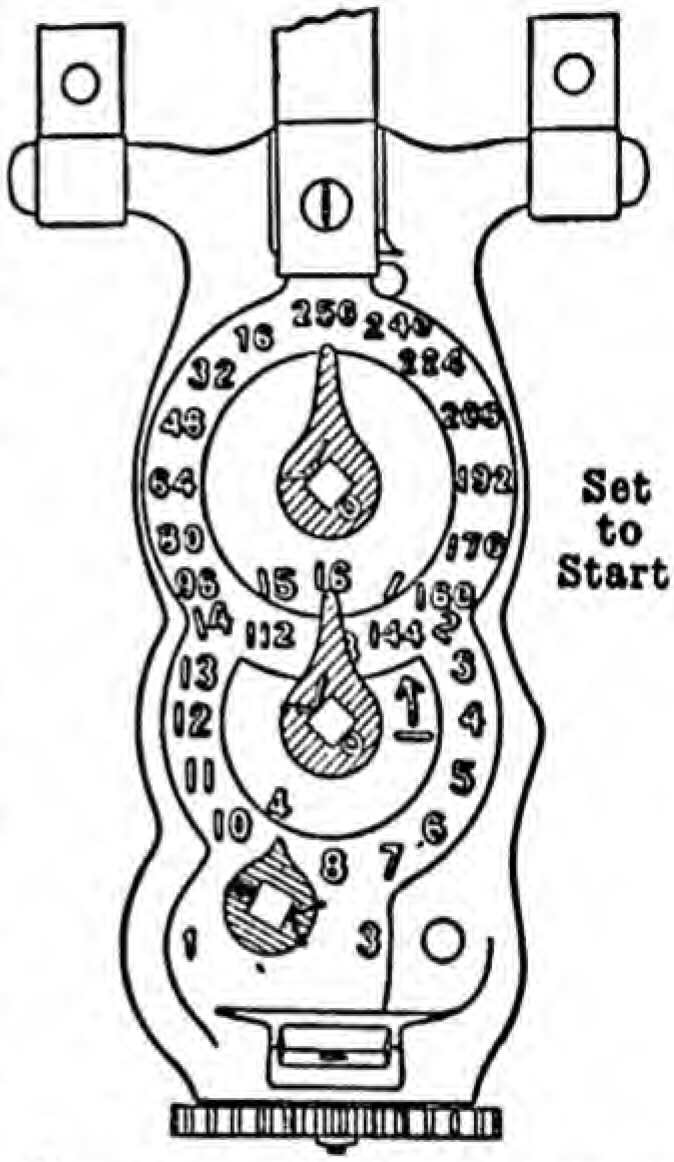


Fig. 337.—Land-measuring device for grain drills.

297. Calibration of Grain Drills.—Many grain drills do not sow accurately, even though the indicator on the dial plate is set correctly. Some will sow more seed than the dial indicates, while others will sow less.

Oftentimes the operator will attempt to check the drill in the field by measuring off a certain acreage, seeding it, and then determining the amount of seed sown. At best, this is a very poor method of checking a drill.

The method of calibrating a drill is as follows: First, find the width of the strip the drill will sow. Measure the distance between furrow openers and multiply it by the number on the drill. Next, find the length of the strip of that width necessary to make 1 acre. This is done by dividing 43,560—the number of square feet in 1 acre—by the width of the strip sown by the drill. The result will be the distance the drill must travel to sow 1 acre of grain.

Now, find the number of times the wheels on the drill will turn in going this distance by dividing the distance to be traveled by the circumference of the wheel.

Fill the seed box with grain.

Set the indicator on the scale to sow whatever quantity of seed is desired.

Jack up the drill and place a paper bag under each seed tube.

Tie a rag around each tire so each revolution of each wheel can be counted.

Engage the clutch and turn the wheels, counting each revolution. Turn them about the same speed they would travel in the field. When the wheels have been turned the equivalent of $\frac{1}{4}$ or $\frac{1}{2}$ acre, collect and weigh the grain. The weight of grain sown by each feed should be recorded separately, so that each feed cup can be checked. To figure on an acre basis, multiply the amount by 4 if $\frac{1}{4}$ acre was selected, and by 2 if $\frac{1}{2}$ acre was sown.

If the indicator is set to sow 8 pecks, 8 pecks should have also been collected. If only 6 pecks of grain are collected the drill is in error.

The percentage of error of the indicated quantity is calculated by dividing the difference between the quantity collected and the quantity the indicator was set on by the indicated quantity.

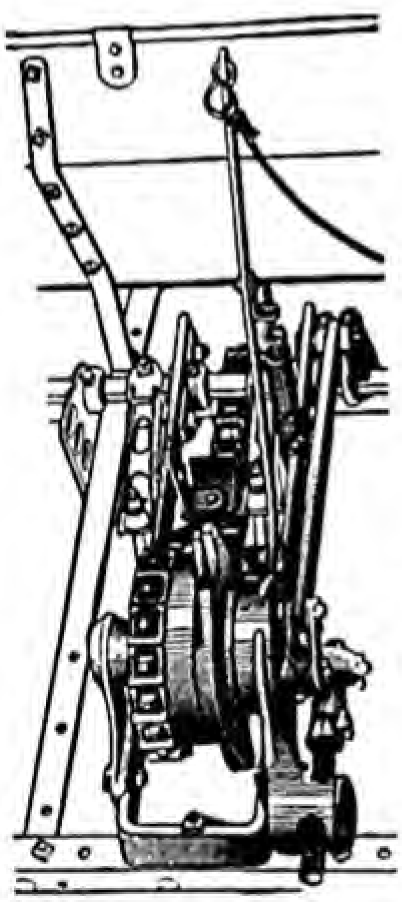


FIG. 338.—Power lift for grain-drill furrow openers.

For example, the difference between the quantity collected and the quantity the indicator was set on in this case is 2 pecks. Dividing this by 8, the indicated quantity, gives an error of 25 per cent.

298. Furrow-opener Lifts.—The furrow openers are lifted either by hand levers or by power-lifting devices. If by hand, one lever is provided for each half of the furrow openers. When the drill is large and drawn by a tractor, power lifts (Fig. 338) similar to those used on plows make it possible for the tractor operator to raise and lower the furrow openers by simply pulling a rope to engage the clutch. Some of the larger drills are equipped with hydraulic lifts.

299. Tractor Hitches.—Where the ground is level and the acreage to be seeded is large, several grain drills may be arranged in such a manner that they all can be hitched to one tractor. One drill is usually hitched directly behind the tractor; then, with a specially designed hitch shown in Fig. 339, other drills are hitched to each side. As many as five large drills may be hitched to the same tractor. A grain drill should be hitched to the tractor so that the frame and seed box are level (Fig. 340).

300. Grass-seed Attachment.—A grass-seeding attachment can be secured for all grain drills. When used, it is attached in front of the main seed box, as shown in Fig. 324. The fluted-wheel type of feed is used in the feed cups. The seed tubes may either empty directly into the regular grain-seed tube or may be clamped to the side so as to allow the grass seed to fall behind the furrow openers.

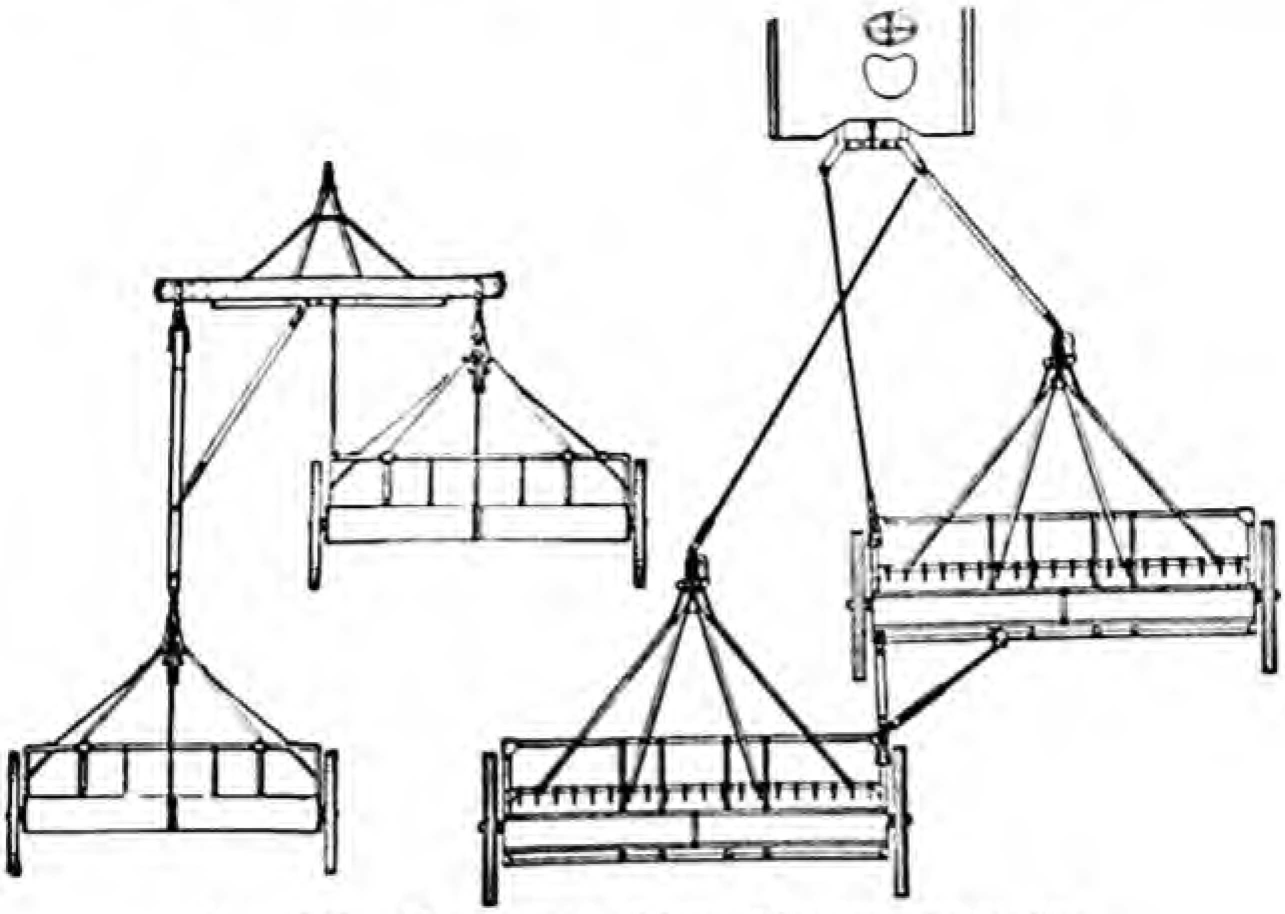


FIG. 339.—Two types of two-drill tractor hitch.

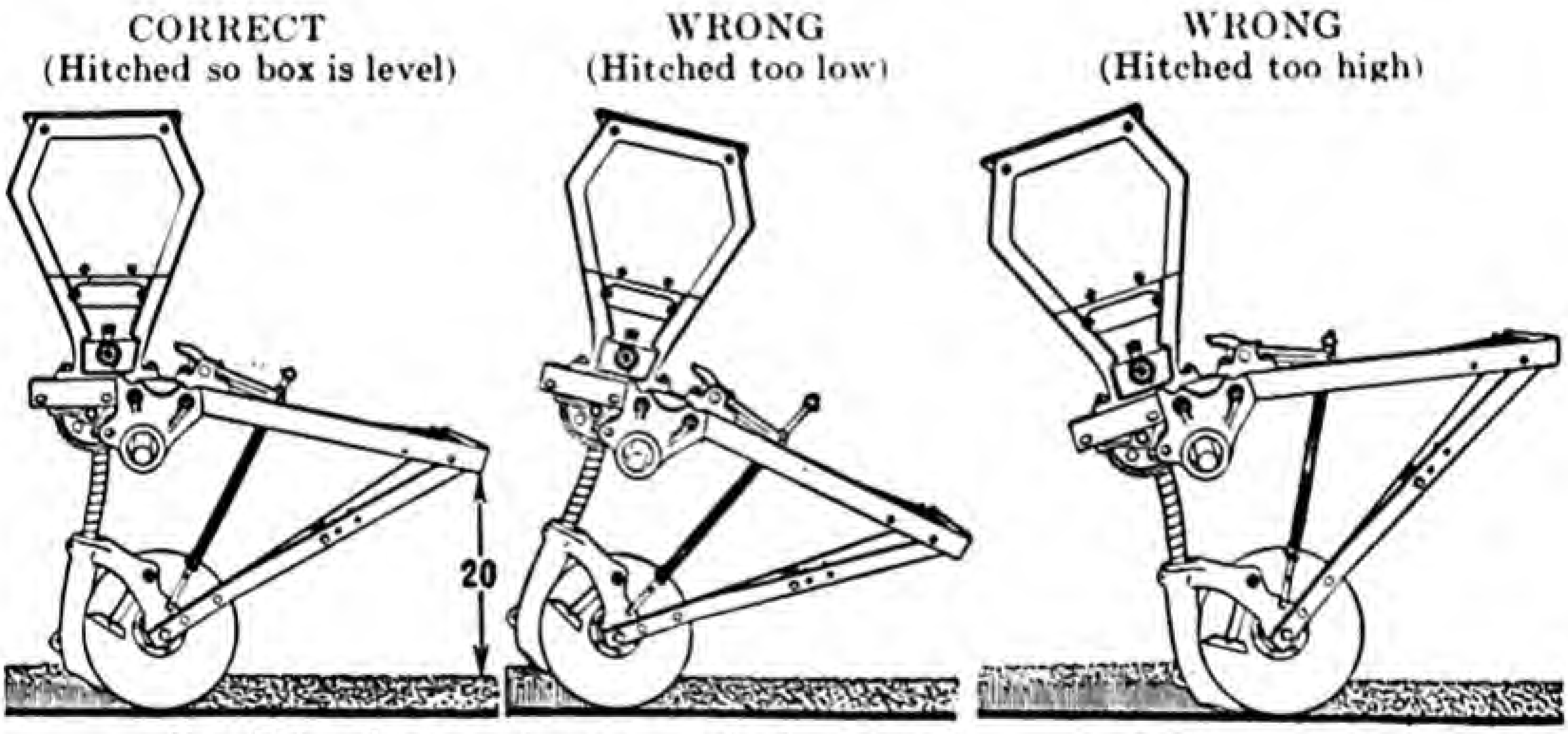


FIG. 340.—Right and wrong methods of hitching grain drill to tractor.

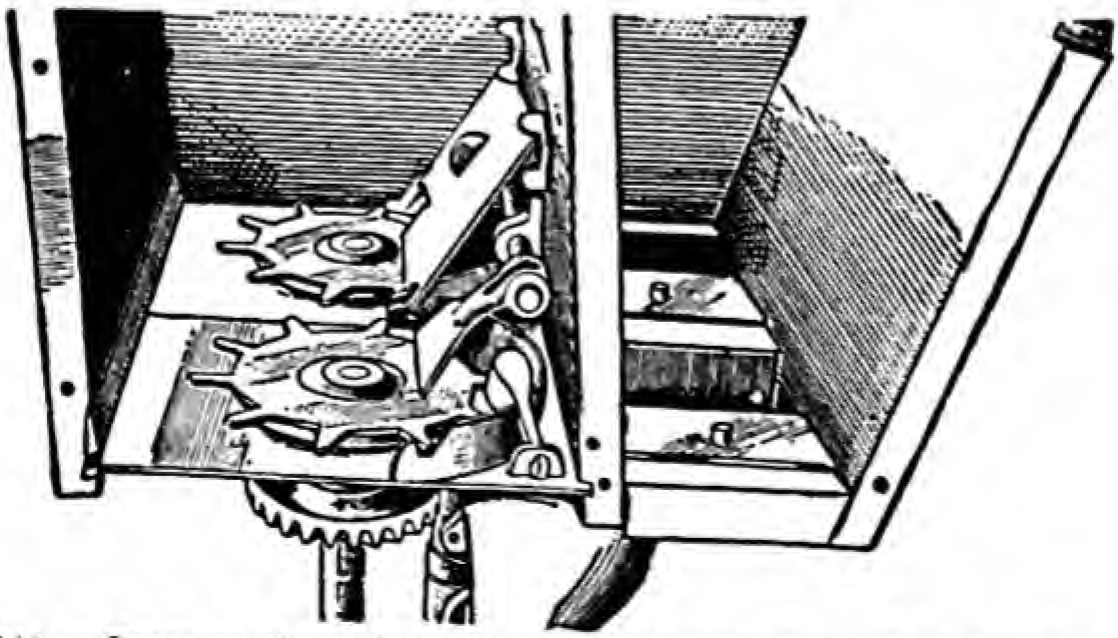


FIG. 341.—Cross section of fertilizer drill showing grain and fertilizer feeds.

301. Fertilizer Attachments.—When a fertilizer attachment is used the drill is usually known as a *fertilizer* drill, even though it is equipped with the regular grain-sowing feeds. Figure 341 shows a cross section

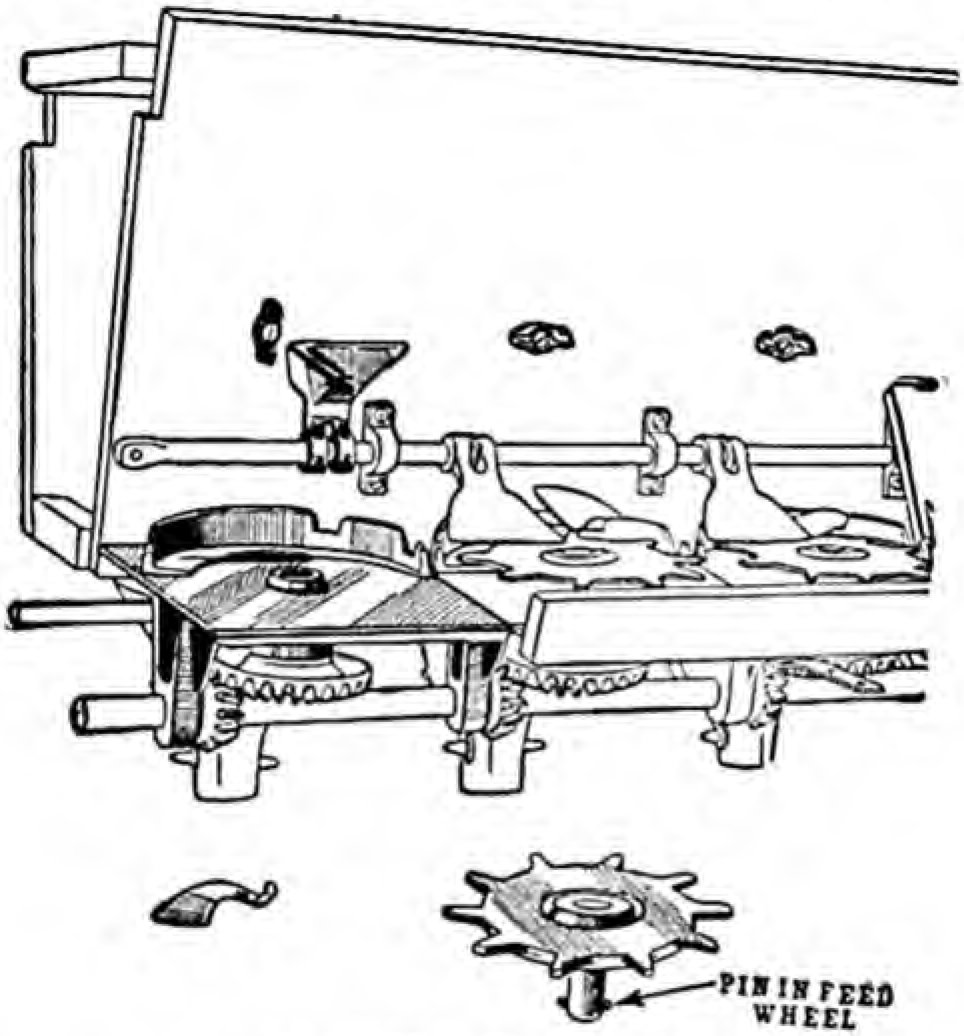


Fig. 342.—Fertilizer feed.

of a fertilizer drill. The feed for distributing the fertilizer is shown in detail in Fig. 342 and is the same as will be described under Fertilizer Machinery. The regular grain-seed tube serves as a spout to conduct

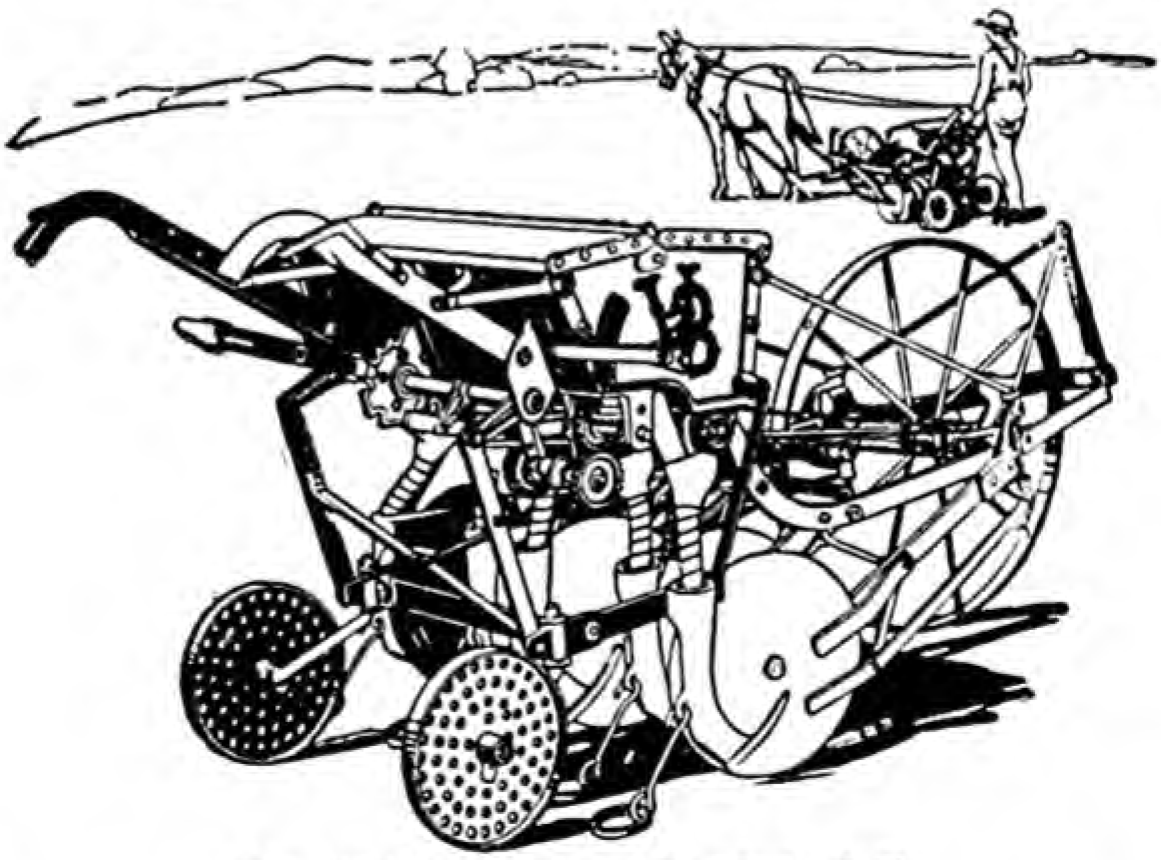


Fig. 343.—One-horse five-hole drill.

the fertilizer down to the soil and prevents the wind from blowing part of it away.

302. One-horse Drill.—It is often desirable to sow some of the small grains, peas, or soybeans between the rows of growing crops at the last

cultivation. A special type of drill for doing such work has been made in the form of the one-horse five-hole drill shown in Fig. 343. It is a rather short, narrow machine having a seed box, steel wheels, and furrow openers on the same principle as the regular type. The weight of the machine is carried on a large wheel in front and two small ones behind. The large wheel in front acts as a drive wheel, transmitting power to the grain feeds by means of a chain and sprocket. Handles are provided for the operator to guide the machine. Grass-seed and fertilizer attachments may be secured on these machines.

303. Alfalfa Drill.—Alfalfa and grass seed are sown in rows closer together than the average grain drill will sow them. A special drill having furrow openers 4 inches apart is now being made. This makes

TABLE XII.—DUTY OF SEEDING MACHINERY

Location and item	Crew[1]	Rate, acres	Location and item	Crew[1]	Rate, acres
General United States:			Nebraska:		
6-foot drill	1—2	9.1	Phelps County:		
8-foot drill	1—3	12.2	7-, 8-foot drill	1—3.5	11.4
8-foot drill	1—4	14.6	Saline County:		
8-foot drill	1—6	16.9	7-, 8-foot drill	1—4.3	11.9
Western New York:			Keith County:		
9-hoe drill	1—2	9.6	3-6-, 7-foot drill	1—3.3	10.8
10-hoe drill	1—2	10.0	Kansas:		
11-hoe drill	1—2	10.4	Pawnee (tractor) 12-, 16-hoe drill	3—0	35.0
Central Illinois:					
8-foot drill	1—4	14.7	Nebraska:		
Utah	1—2	11.1	Phelps drill (tractor)	1—0	17.8
Kansas:			Keith drill (tractor)	1.7—0	36.4
Ford County:			Central Illinois:		
8-, 12-foot drill	1—4.8	18.2	End-gate seeder:		
Pawnee County:			20.2 feet	1—2	38.5
8-, 12-foot drill	1—4.5	17.4	25.8 feet	1—2	43.3
McPherson County:			30.0 feet	1—2	48.6
8-, 12-foot drill	1—4	15.6	34.9 feet	1—2	51.3
Missouri:			39.0 feet	1—2	58.2
Saline County:			General United States:		
7-, 8-foot drill	1—3.5	12.5	Knapsack	......	23.0
Jasper County:			Wheelbarrow, 14-foot	......	21.0
6-, 7-, 8-foot drill	1—3.2	11.7	Louisiana:		
St. Charles County:			Broadcast by hand:		
8-, 10-foot drill	1—3.1	10.5	1½ bushels per acre	......	12.50
			2 bushels per acre	......	14.11

[1] First figure refers to number of men and second figure to number of horses in crew.
U. S. Dept. Agr. Yearbook, 1922.

an excellent drill for sowing alfalfa, clover, redtop, timothy, bluegrass, rape, sudan grass, millet, flax, and hemp. These different seeds can be planted in a large variety of quantities to the acre. There is no great difference between the alfalfa and regular drills other than that the feed cups and furrow openers are placed closer together on the alfalfa drills. The feed wheels are the internal, double-run, force-feed type and are made smaller than those on the regular drills. In some types of drills the speed of the grain feeds is changed by an arrangement of spur gears.

304. Draft of Grain Drills.—Kranich[1] states that the draft of a plain drill will average around 6 pounds per furrow opener per inch of depth. The kind of seed being sown, the quantity in the seed box, the depth of seeding, the type of soil and its moisture content, the grade, and the condition of the drill are important factors that will influence the draft of a grain drill.

305. The Duty of Seeding Machinery.—Table XII shows the number of men and the power required to operate the various types of seeders. The table also shows the acreage sown in a 10-hour day for the various types.

[1] KRANICH, F. N. G., *Farm Equipment*, The Macmillan Company, New York, 1923.

PART VI
CULTIVATING MACHINERY

CHAPTER XVIII

CULTIVATORS

About half the labor of growing a crop is spent in the preparation of the seedbed and the planting of the seed. When the seed have germinated and the plants are just beginning to get above the top of the soil, it is time to begin stirring the soil around them to prevent and destroy weeds, to keep the top of the soil in such condition as to conserve moisture, and to allow the circulation of air beneath the surface of the soil. All of these are beneficial to the plant, as is seen in the way it thrives.

The main purpose in mind, when cultivating, is to promote the growth of the crop. Otherwise, no cultivation would be needed. The question is, what are the various ways of promoting growth by cultivation? Some are as follows:

1. Retain moisture by
   a. Killing weeds.
   b. Loose mulching on surface.
   c. Retaining rainfall.
2. Develop plant food.
3. Aerate the soil to allow oxygen to penetrate soil.
4. Promote activity of microorganisms.

Many types of cultivators are in use, ranging all the way from the small hand-pushed garden cultivator suitable for the family garden to large four-row tractor-mounted cultivators capable of cultivating 60 to 80 acres per day. The type and size needed will depend upon the acreage, the kind of crop, soil type and conditions, rainfall, type of farming practiced, and the kind of power available.

WALKING CULTIVATORS

306. Garden Cultivators.—Figure 344 shows a typical garden cultivator. It is used with either single or double wheels. The cultivating equipment includes a pair of hiller hoes, cultivator teeth, rake teeth, and a plow. Any of the tools used must be operated by hand power.

FIG. 344.—Garden cultivator showing various attachments.

307. One-half-row One-horse Walking Cultivator.—Where the farm includes only a few acres and these probably not cleared of stumps, the one-half-row walking cultivator, shown in Fig. 345, is almost a necessity. Through the timbered belt of the East and South, this type of cultivator

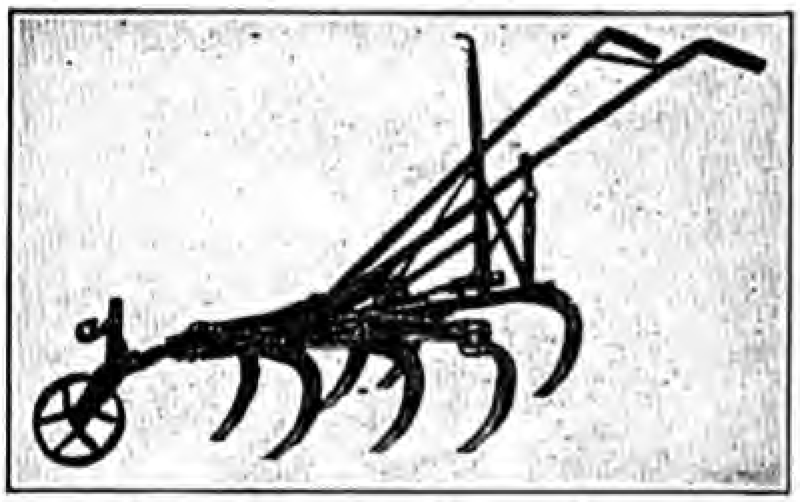


FIG. 345.—Seven-tooth one-horse one-half-row cultivator.

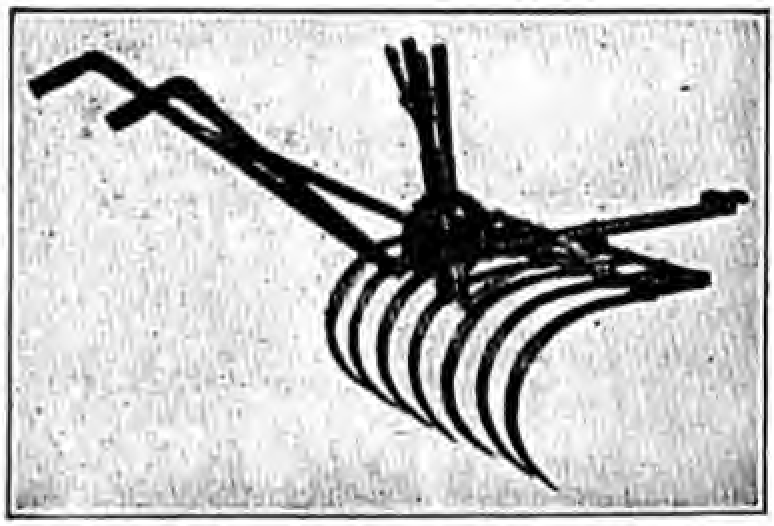


FIG. 346.—Spring-tooth one-horse cultivator.

is used quite extensively, but it is not advised that it be used where any other type can be substituted. To cultivate one row it is necessary to make one trip across the field cultivating half of the middle between the rows and another trip cultivating the other half.

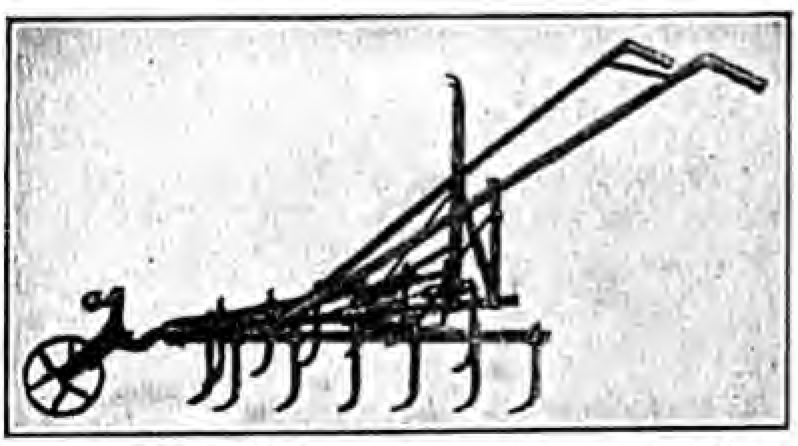


FIG. 347.—Fourteen-tooth scratcher cultivator.

Using this cultivator to cultivate 40 acres, with the rows 3 feet apart, one, two, three, or four times, a man would travel 219.5, 438.0, 658.5, and 878.0 miles, respectively.

Some of the better types of one-horse one-half-row cultivators have from five to fourteen shovels placed irregularly on the frame, which can

be adjusted for width. Figures 346 and 347 show a five-tooth spring-tooth and a fourteen-tooth cultivator. If the soil is in good condition, without large weeds or grass, one complete middle may be cultivated at

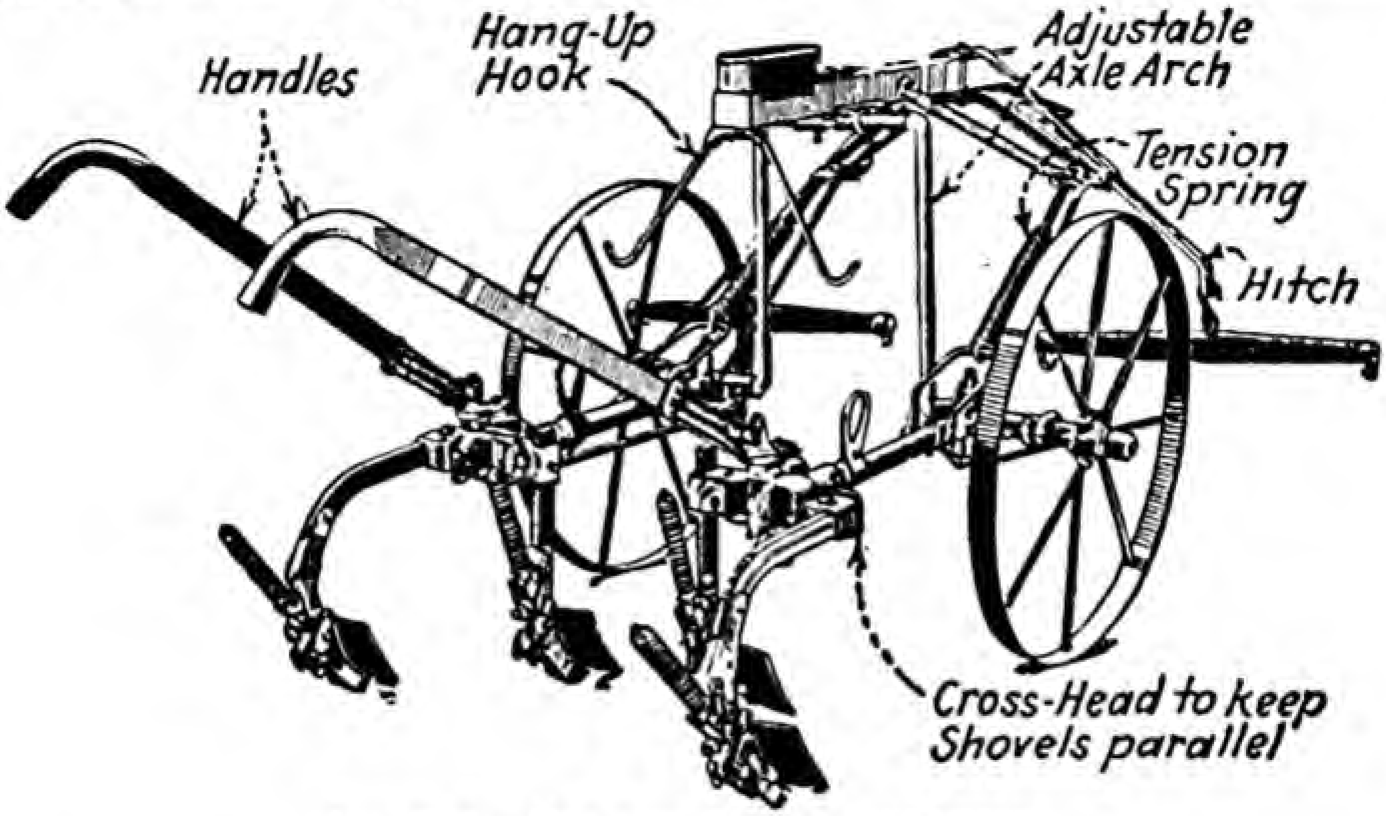


FIG. 348.—One-row walking cultivator.

one trip across the field. If it is not desired to cultivate the complete middle, the shovels can be drawn closer together by narrowing the frame and one-half row cultivated at one trip across the field.

FIG. 349.—Cultivating young cotton with walking cultivator. (*Courtesy of Anderson Clayton Company.*)

308. One-row Two-horse Walking Cultivator.—This cultivator, as shown in Fig. 348, will cultivate both sides of the row at one trip across the field. Two horses are used to pull the machine. This cultivator is

mounted upon two wheels and a U-shaped axle, which is adjustable for width. It also has gangs or rigs to which shovels are attached by means of shanks. There may be two or three shovels to the gang. A handle is attached to each gang to enable the operator to control the gangs, shifting them to the side to dodge plants. The parallel shift or crosshead gang shown in Fig. 348 prevents the shovels trailing when shifted sidewise. Each gang is provided with lifting springs to aid in lifting and carrying the greater part of the weight, thereby relieving the operator. When they are not in use, the gangs can be hung up on the hang-up hooks.

On all shovel shanks some provision is made to prevent bending, twisting, and breaking the beam and shank. The methods are the wooden pin, friction trip, and the spring trip shown in Fig. 350.

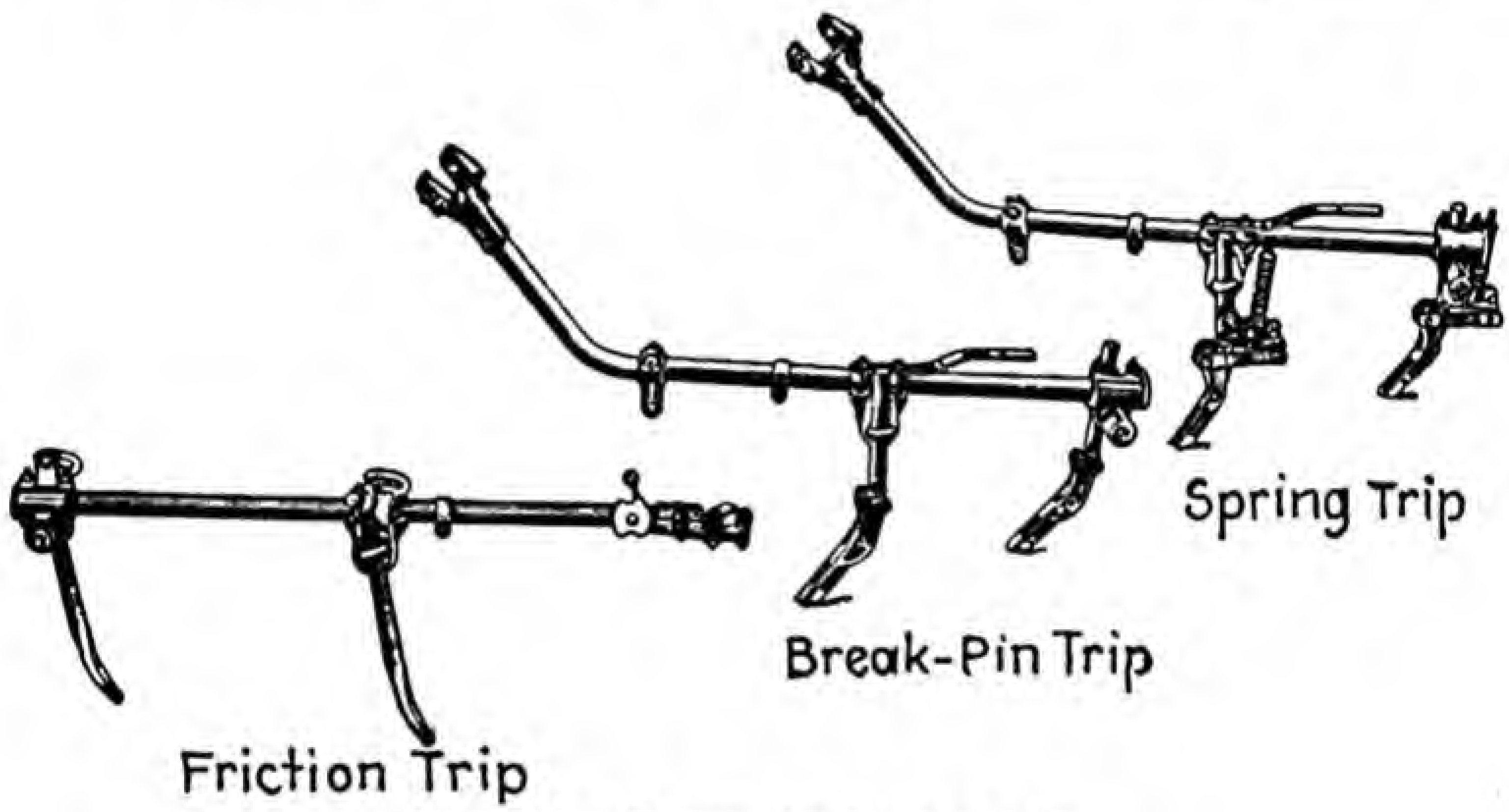


Fig. 350.—Types of cultivator trip.

Plantation owners claim that better results can be obtained by having the man walk than by putting him on a riding cultivator, as he will pay more attention to what he is doing while walking than while riding and will thus do a better job of cultivation.

To cultivate 40 acres one, two, three, and four times, with a one-row walking cultivator, a man is required to walk 109.7, 219.5, 329.2, and 439.0 miles, respectively.

RIDING CULTIVATORS

309. One-row Two-horse Riding Cultivators.—One-row riding cultivators may be classed, according to the type of cultivating unit used, as shovel, disk, and surface.

The *shovel cultivator*, with its large variety of shovels, sweeps, and attachments, is the most widely used of all types. A typical one-row riding cultivator is shown in Fig. 351.

The *disk cultivator* is not extensively used but finds favor where the plants are grown on ridges or the field is infested with vines. The revolving disks readily cut the vines, thereby preventing their collecting on the gangs. The disk gangs have a wide range of adjustment; they

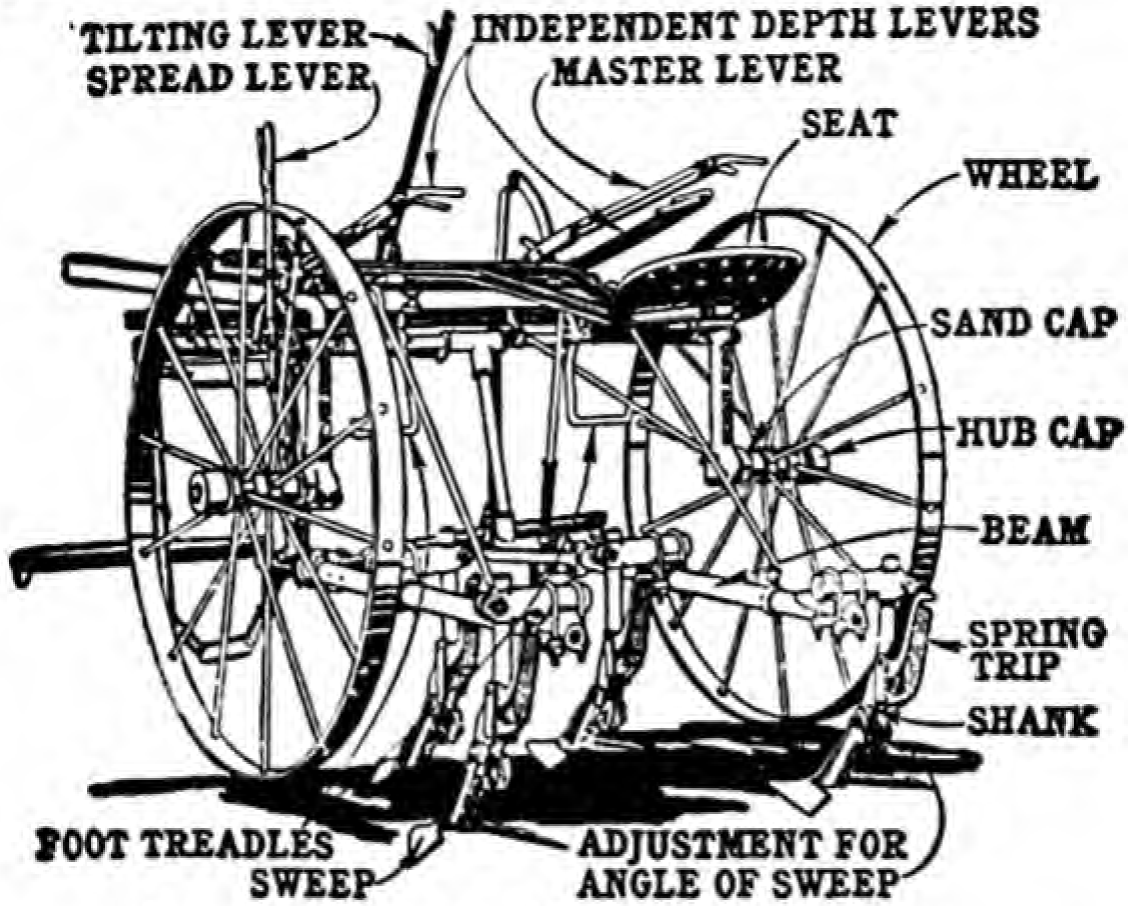


FIG. 351.—One-row riding shovel cultivator.

can be set to throw the soil either toward or away from the plants at any desired angle.

Most disk cultivators can be converted into a shovel or spring-tooth cultivator by changing the gangs.

The *surface cultivator* is equipped with long blades which do not penetrate deeply. The blades are set at an angle and with sufficient pitch to slice off the weeds and stir the surface of the soil. If deeper penetration is desired, the pitch of the blades is changed to dig in deeper. It is essential that the blades on both sides be set with the same angle, to prevent the gangs crowding to the right or to the left.

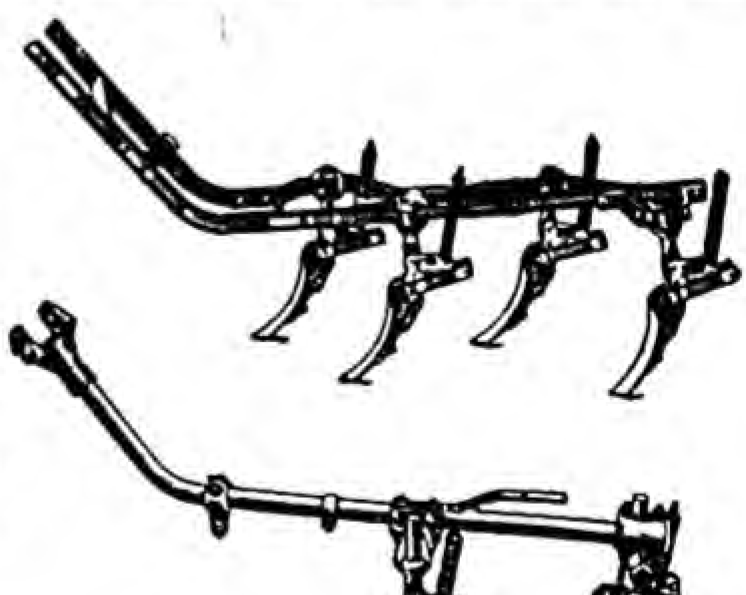


FIG. 352.—Cultivator gangs.

As shown in Figs. 350 and 352, the *gang* or *rig* is the complete assembly of beam, shanks, and shovels. There are two to each row. Cultivators may be equipped with four, six, or eight shovels.

The *beam* may be made of round, square, flat, I-beam, or channel steel. The connection of the beam to the frame is an important feature

to consider in selecting a horse-drawn cultivator. Two methods of connecting the gangs and the effect on operation are shown in Figs. 353 and 354.

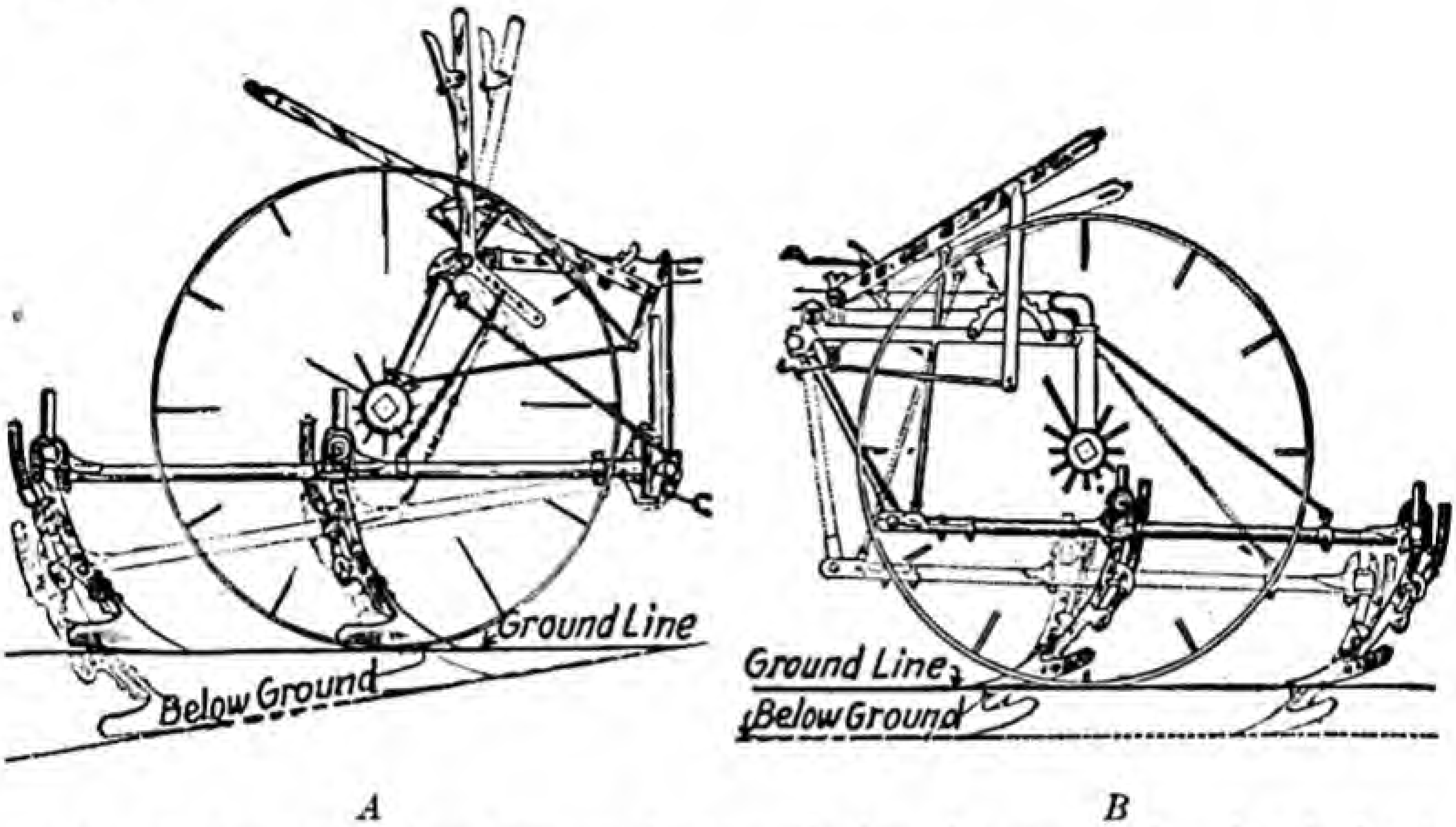


FIG. 353.—*A*, shows how shovels enter the ground when the gang is hinged at the front and lowered by the lever; *B*, shows uniform depth of shovels on entering the soil.

Figure 353 shows how the type of connection will influence the uniformity of penetration of the shovels.

Figure 354 shows how the lateral movement is influenced.

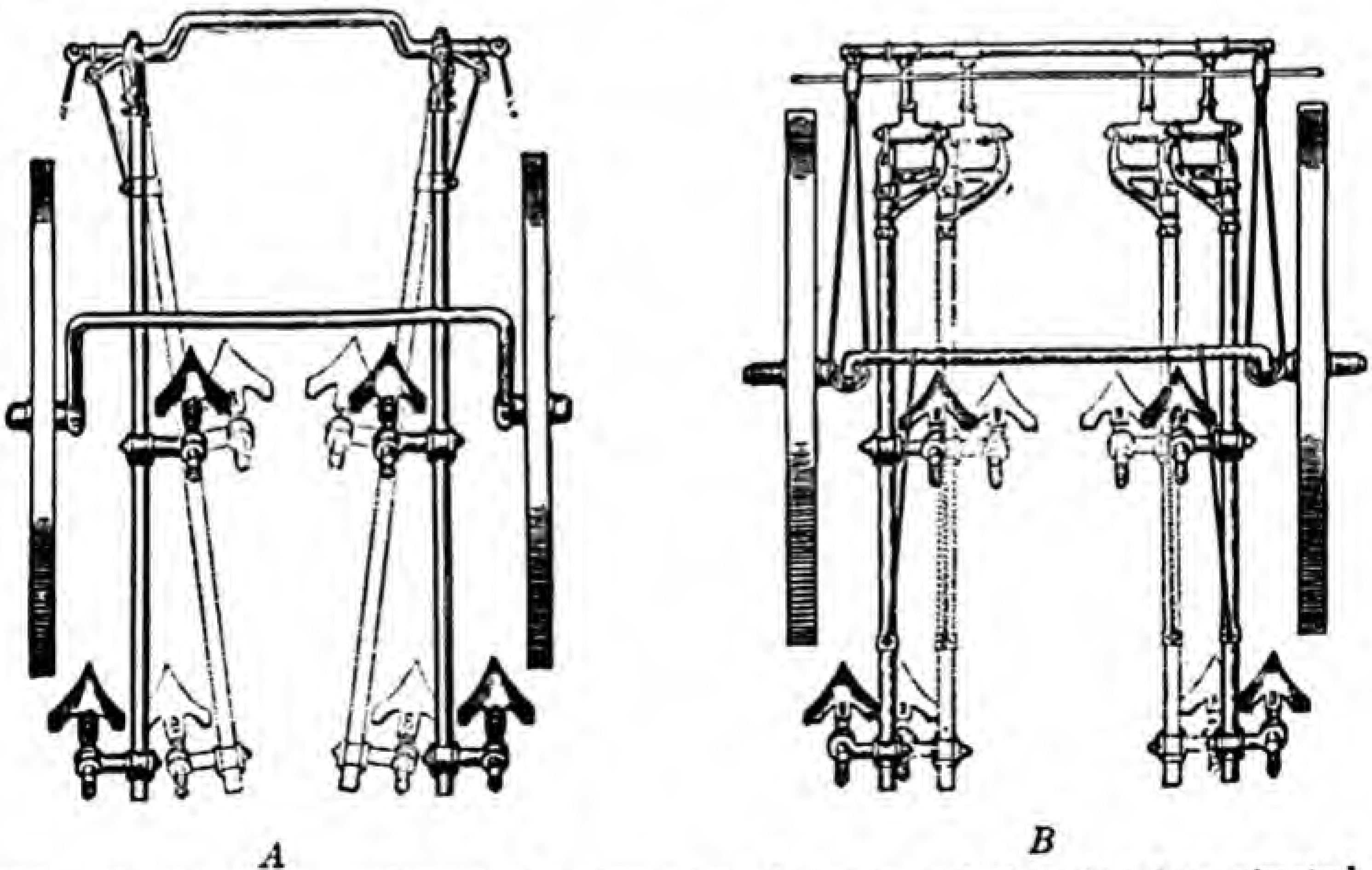


FIG. 354.—*A*, shows the action and movement of gangs and shovels when pivoted at the front; *B*, shows the movement when the gangs are shifted parallel.

Figure 355 shows various settings for cultivator shovels. The setting recommended for shovels is a 47-degree angle. Where sweeps are used, they should be set flat.

To prevent breaking or twisting the shank when the shovel strikes an obstruction, it is necessary to have a safety device. This is called a *trip*. There are three types, namely, the break pin, the friction, and the spring trip (Fig. 350). The last is most used and is shown in operation in Fig. 356.

There are many different types of both shovels and sweeps, as shown in Fig. 357.

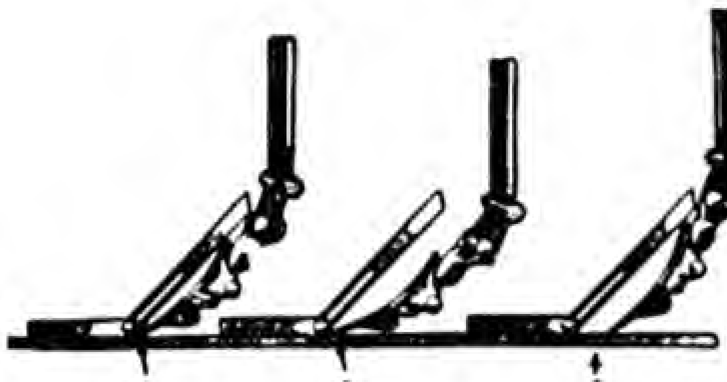


FIG. 355.—Showing correct and incorrect pitch of cultivator shovels: 1, shovel properly adjusted; 2, shovel set too flat; 3, shovel set too straight, will not penetrate or run steadily.

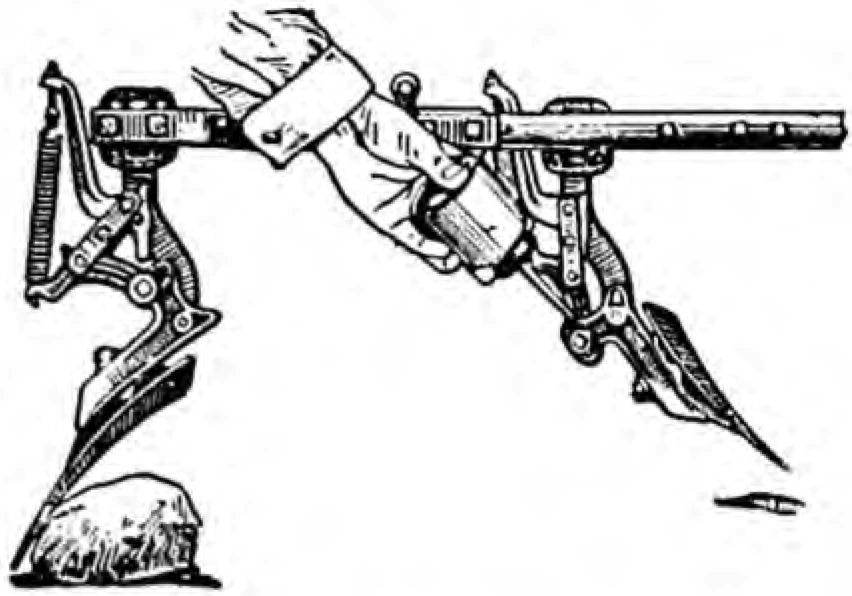


FIG. 356.—Cultivator spring trip: *A*, trip in action; *B*, trip should be oiled.

310. Gang Controls.—The most common methods of controlling cultivator gangs so they will follow the row and not plow up the plants are the direct foot control, the seat guide, the pivot axle, the parallel shift, and the combination parallel shift and pivot axle.

The gangs of the *direct-foot-control* cultivator are fastened to the front arch by pivot couplings and are suspended at the rear by steel pipes or pendulums fastened at the top to rocker arms, which project from the axle arch (Fig. 358). Handles on the pendulums and stirrups on the gangs enable the operator to handle the gangs with his hands, or feet, or both.

The *seat guide* control is often known as the *wiggletail*, *pivot pole*, or *pivot frame*. The gangs are controlled by shifting the seat sidewise by an easy swaying motion of the body aided by pushing with the feet against the gangs. The seat support, which is fastened to the axle arch, extends to the rear for the seat and to the front where it pivots with the rear end of the tongue. Therefore, when the rear end of the tongue is moved sidewise, to right or left, by shifting the seat, the frame, wheels and gangs are angled in the opposite direction.

The *pivot axle*, sometimes called a *pivot-wheel* cultivator, gets its name from the way the wheels are pivoted to the right or left. Foot pedals,

extending toward the center of the machine, are placed on the axle. Both wheels are so connected that they swing together and remain parallel. A slight pressure on either foot pedal pivots the wheels. No sidewise movement of the gangs is obtained, however, until the cultivator is drawn forward. The whole action is similar to that of steering an automobile.

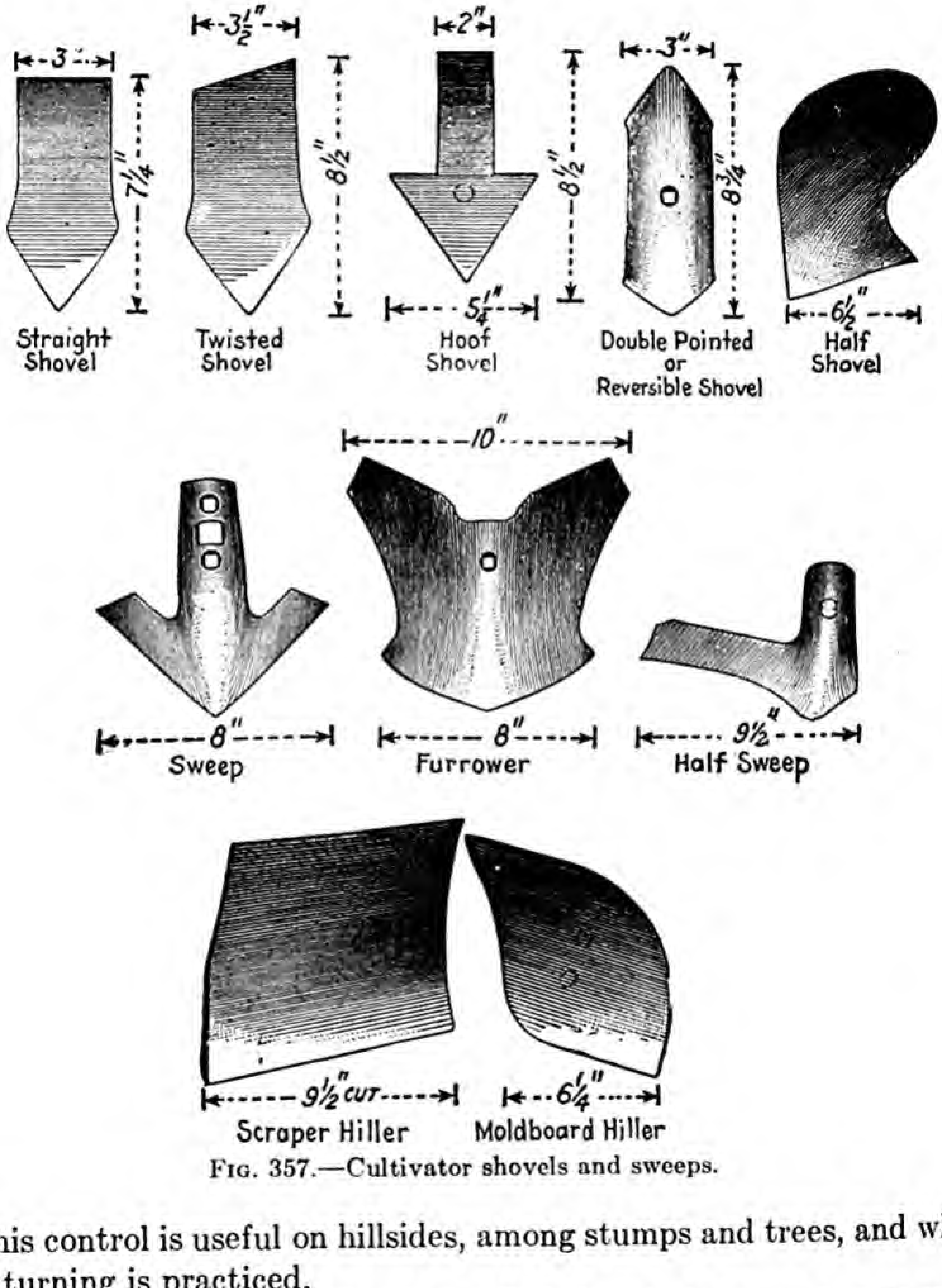


FIG. 357.—Cultivator shovels and sweeps.

This control is useful on hillsides, among stumps and trees, and where short turning is practiced.

The *parallel shift* control is often called the *pivot gang* or *treadle guide.* The gangs are rigidly connected together at the front by bars. Foot levers hanging from the axle arch are connected to the gang bars, usually by chains and pulleys. When it is desired to move the gangs to the

right, the operator pushes forward on the right foot lever. This action shifts both gangs to the right as a unit, keeping them equally spaced from front to rear and also parallel.

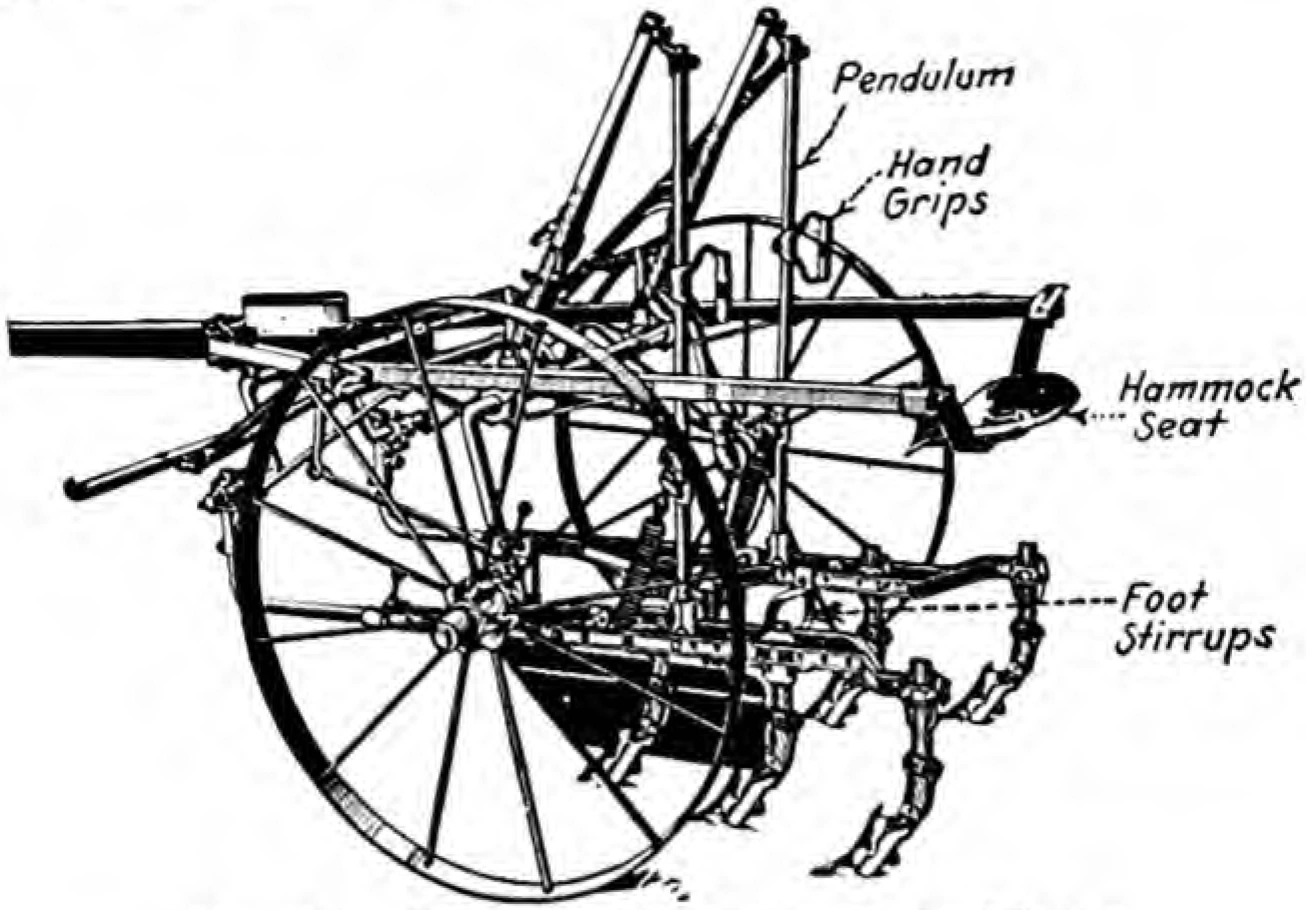


FIG. 358.—Direct foot-controlled type of cultivator.

The tongue, frame, and wheels are held rigid. The gangs are the only parts that shift.

The combination *parallel shift* and *pivot axle* control is extensively used, since it gives a quick response and is easily operated. It is, as the name indicates, a combination of the two shifts already described.

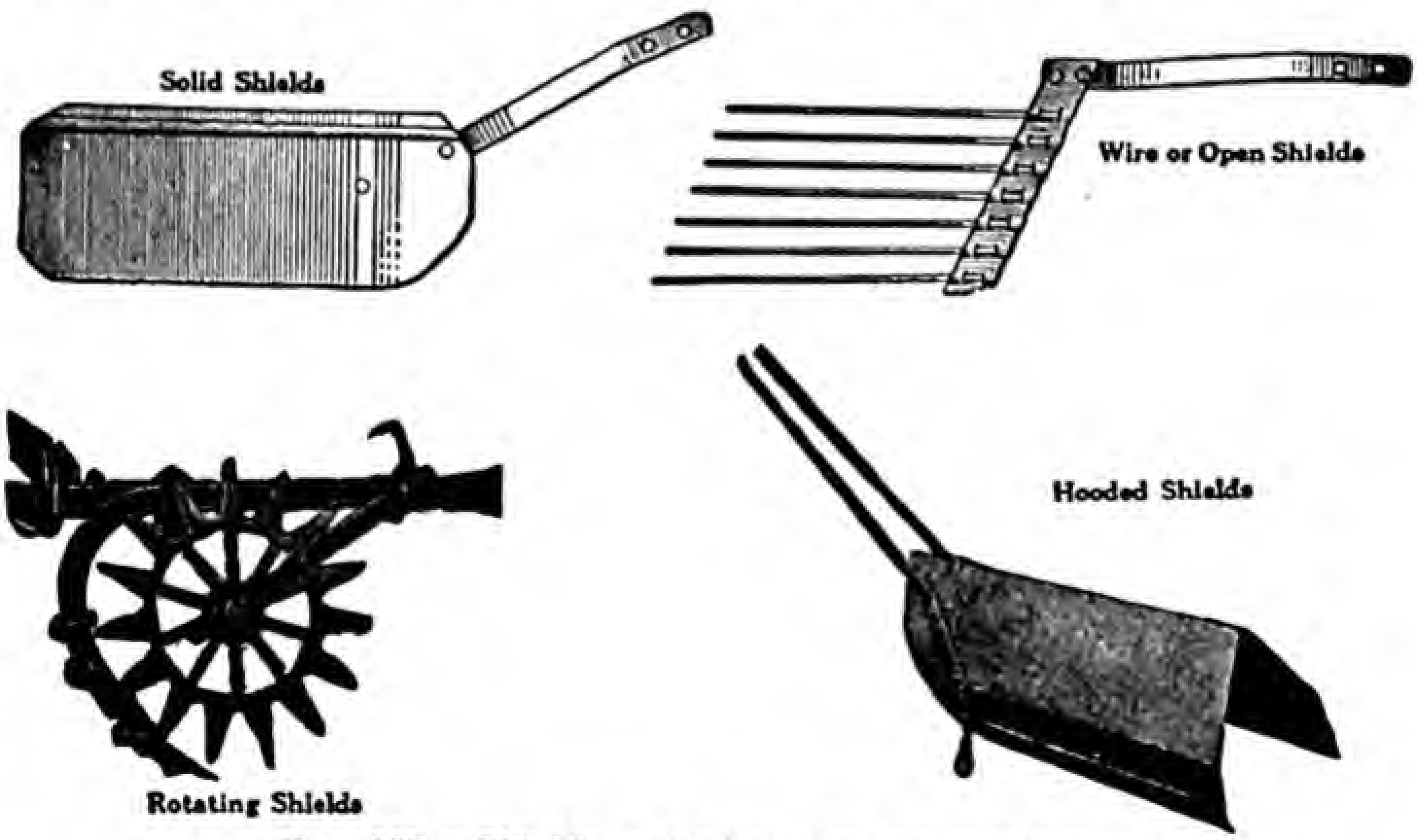


FIG. 359.—Shields or fenders used on cultivators.

311. Special Attachments.—A wide range of attachments suitable for different crops can be secured for riding cultivators. They include shields, disk hillers, wing hillers, spring-tooth attachments, fertilizer

attachments, tobacco-hoeing attachments, center shovel, spring-tooth center shovel, and jockey arch. Some are shown in Figs. 359, 360, and 361.

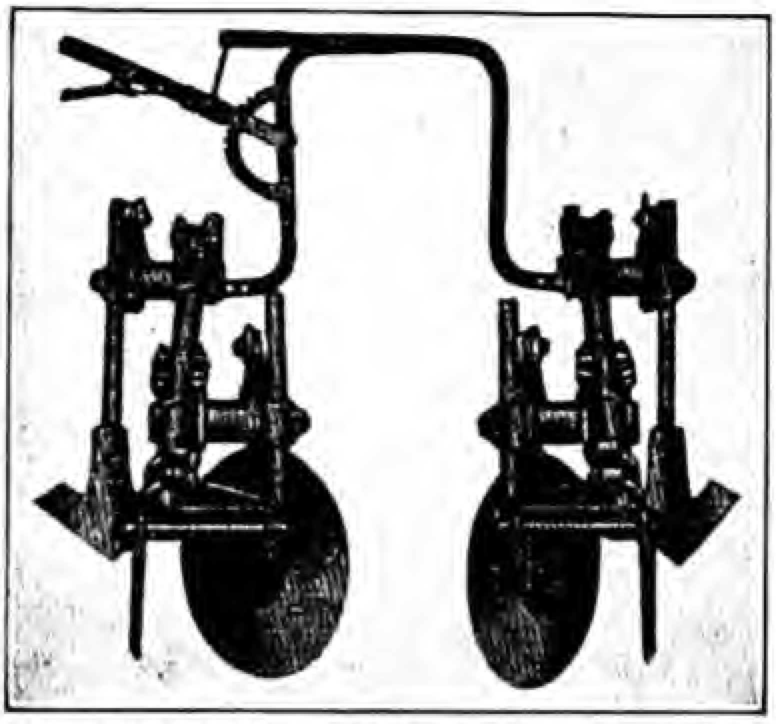


Fig. 360.—Disk-hiller attachment and jockey arch.

312. Two-row Cultivators.—For level country and where planting is done with the two-row planter, a large amount of time, labor, and expense is saved by cultivating with a two-row cultivator. In fact, one-half the time required to cultivate a certain acreage with a one-row outfit is saved by the use of a two-row machine. The average 10-hour-day's work with

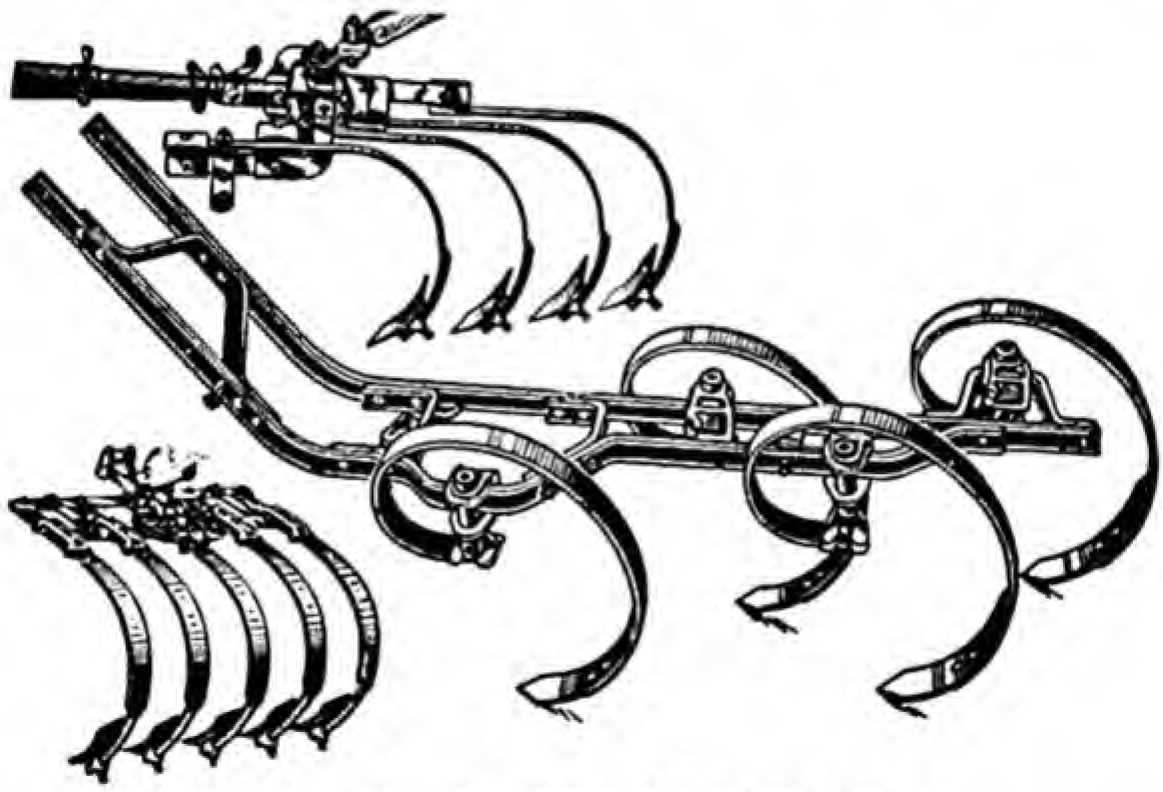


Fig. 361.—Spring-tooth attachments.

a two-row cultivator is 14.7 acres. Three or four horses are required to pull the two-row cultivator.

The distance traveled when cultivating 40 acres with the rows 3 feet apart one, two, three, and four times is 54.9, 109.7, 164.6, and 229.4 miles, respectively. When the rows are 42 inches apart, the distance traveled is 46.2, 92.5, 138.7, and 185.0 miles, respectively.

The principal difference in the construction and handling of the

two-row cultivator and the one-row is that the two-row is built much heavier, especially in the frame and wheels. A master lever is provided to lift all gangs at the same time. Each gang has an independent lever for adjusting the depth. A spacing lever is also provided. These are all shown in Fig. 362. There are three methods of controlling gangs on two-row cultivators: the parallel shift, the pivot axle, and a combination of the parallel shift and pivot axle. The last is practically universally used on most two-row machines now. These controls are the same as described under One-row Cultivators.

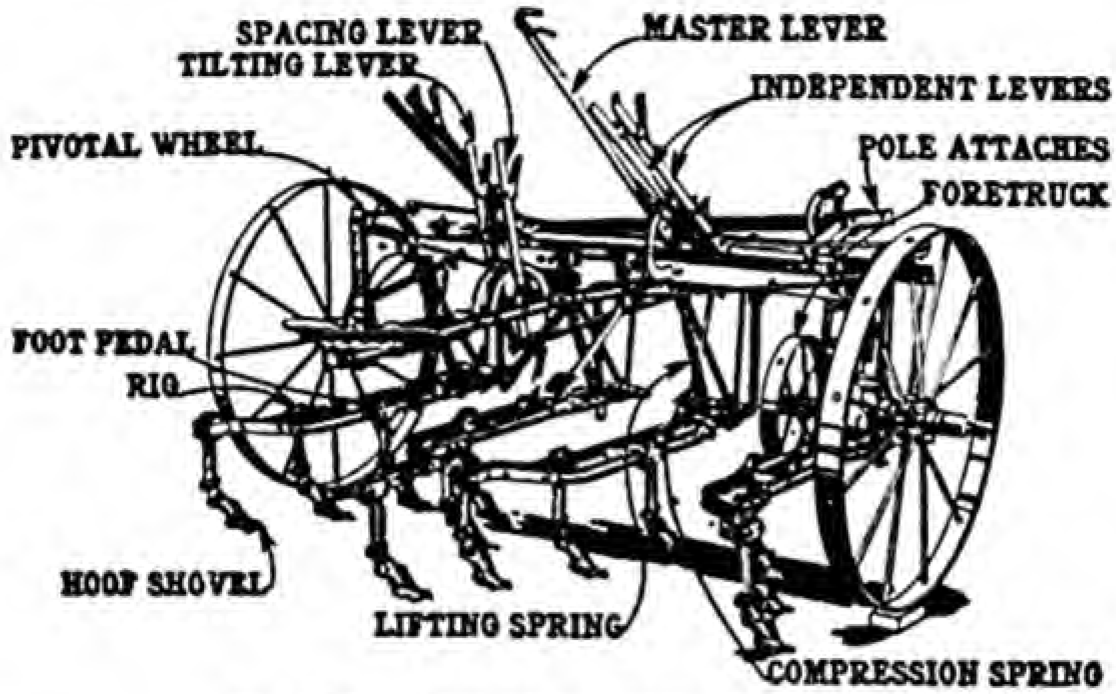


FIG. 362.—Two-row shovel cultivator.

The large two-row cultivators have a special forecarriage or tongue truck to carry the weight of the front of the frame.

TRACTOR CULTIVATORS

The general-purpose tractor with the "tricycle" wheel arrangement was developed primarily as a power unit on which cultivator equipment could be integral-mounted for the rapid cultivation of row crops. Planting and other attachments came later. The number of rows of cotton, corn, and other row crops cultivated at a time depends largely on the size of the tractor and the power available. Of course soil type, the kind of crop, and the depth of cultivation are also influencing factors. Generally, the one-plow-size tractor is equipped with a cultivator attachment for cultivating one row of cotton or corn. The two-plow tractor is generally equipped with two-row cultivators, and the three- and four-plow tractor operates a four-row cultivator.

313. One-row Tractor Cultivator.—Figure 363 shows a one-plow-size tractor equipped with two types of gangs. Sweeps or shovels can be used on the gangs shown to the left. Spring-tooth cultivating units are shown on the right. In each case the sweeps or spring teeth that run close to the plants are suspended underneath the tractor and in front

of the operator. Units are placed to run behind the tractor wheel and loosen the compacted soil. The gangs are shifted horizontally by steering the tractor.

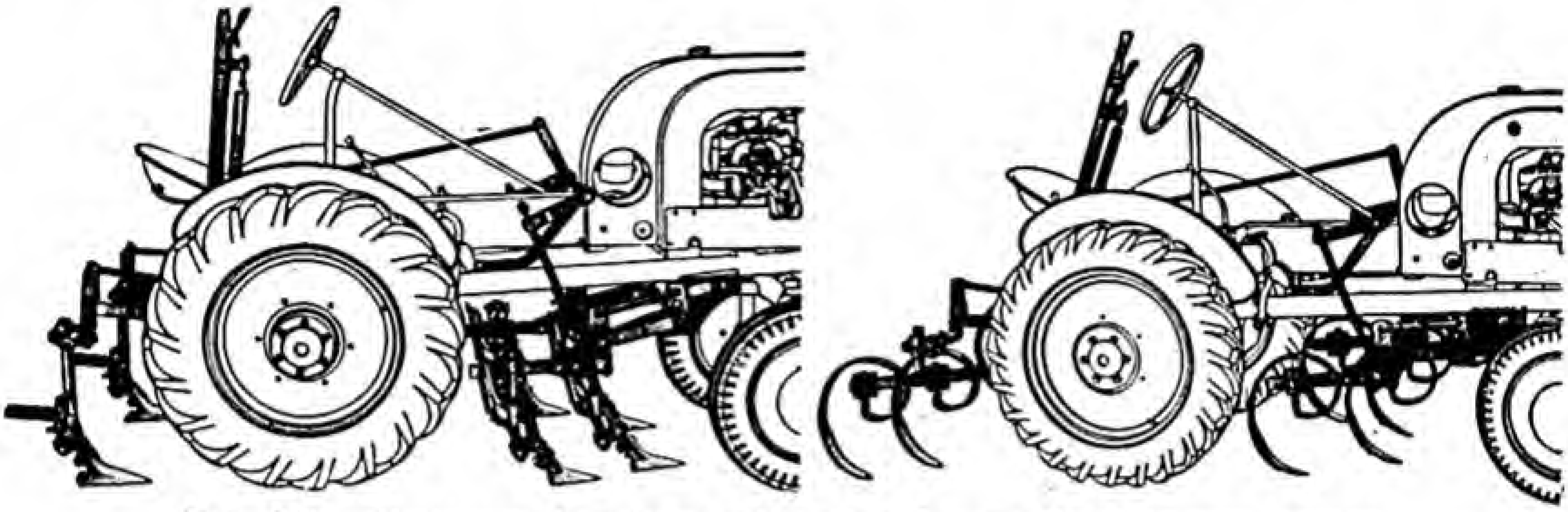


FIG. 363.—Sweep and spring-tooth gangs for small single-row tractor.

314. Two-row Tractor Cultivator.—The most common and popular method of mounting two-row cultivator units is shown in Fig. 364, where the gangs for the cultivator sweeps are well forward and in front of the tractor operator. The sweeps at the rear sweep out the middles and loosen the soil behind the tractor wheels. In most cases shifting of the gangs horizontally is done by steering the tractor. Figure 365 shows an arrangement whereby the gangs are shifted in combination with the

FIG. 364.—Two-row tractor-mounted cultivator equipped with shields, sweeps, and hydraulic lift.

steering. Many different types of shovel and sweep arrangements can be obtained. Disk and spring-tooth gangs are also available (Fig. 366). Tool-bar quick-attachable rear-mounted units as shown in Fig. 367 are available for some makes of tractors. Various types of hand, mechanical, and hydraulic power lifts are used for lifting the gangs. In one type the front gangs for each row can be lifted independently at a different time and before the rear unit is lifted. This is well suited for cultivating point rows.

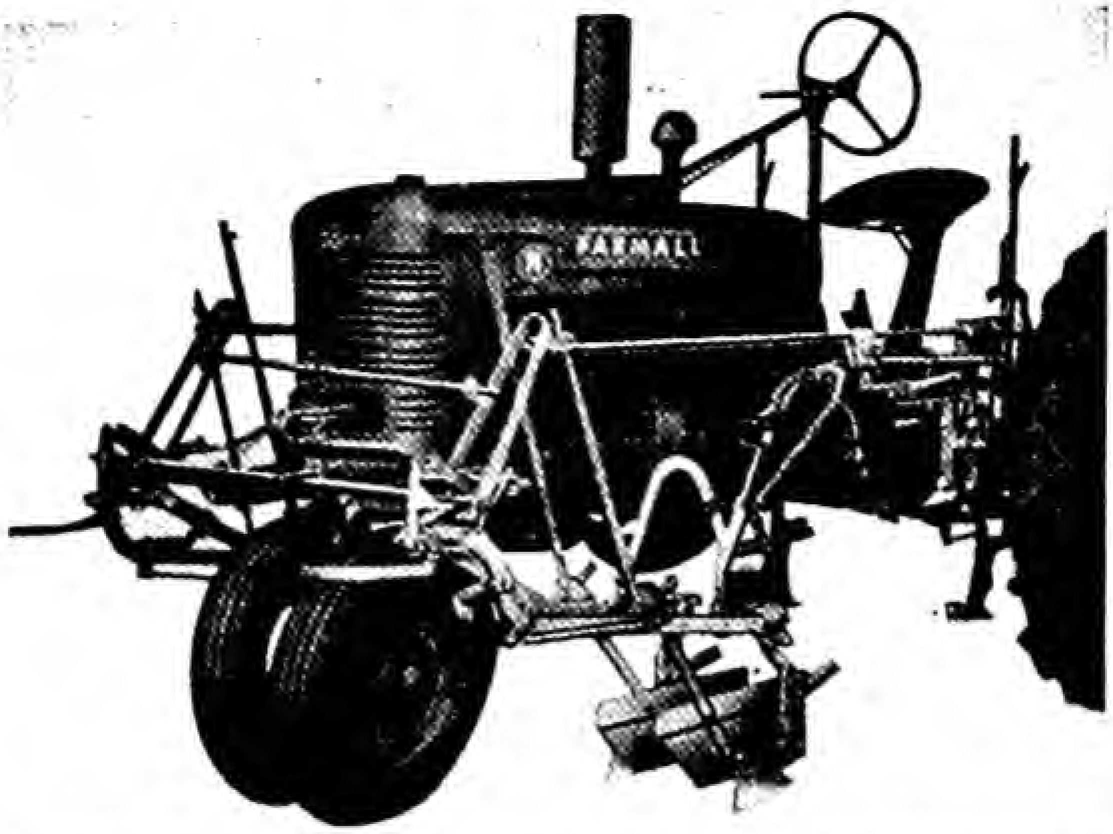


FIG. 365.—Shifting-gang tractor cultivator. A connection from the gangs to an arm extending to the front on the steering post causes the gangs to shift as the front wheels of the tractor are turned. This arrangement almost doubles the speed of the shift and aids in dodging plants or hills out of line.

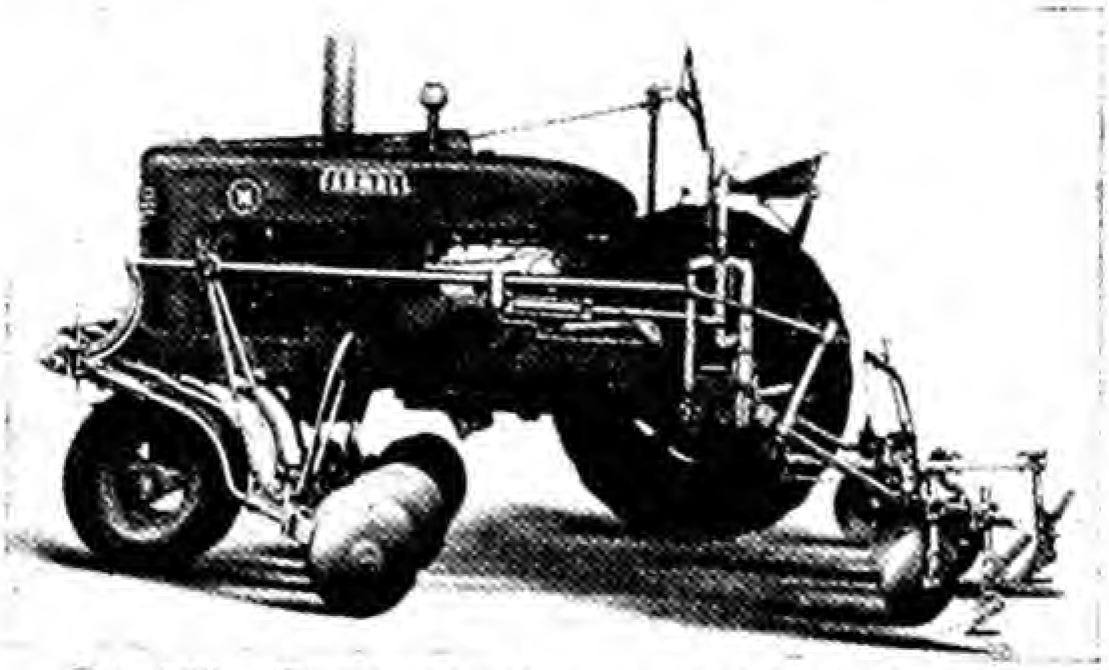


FIG. 366.—Two-row tractor-mounted disk cultivator.

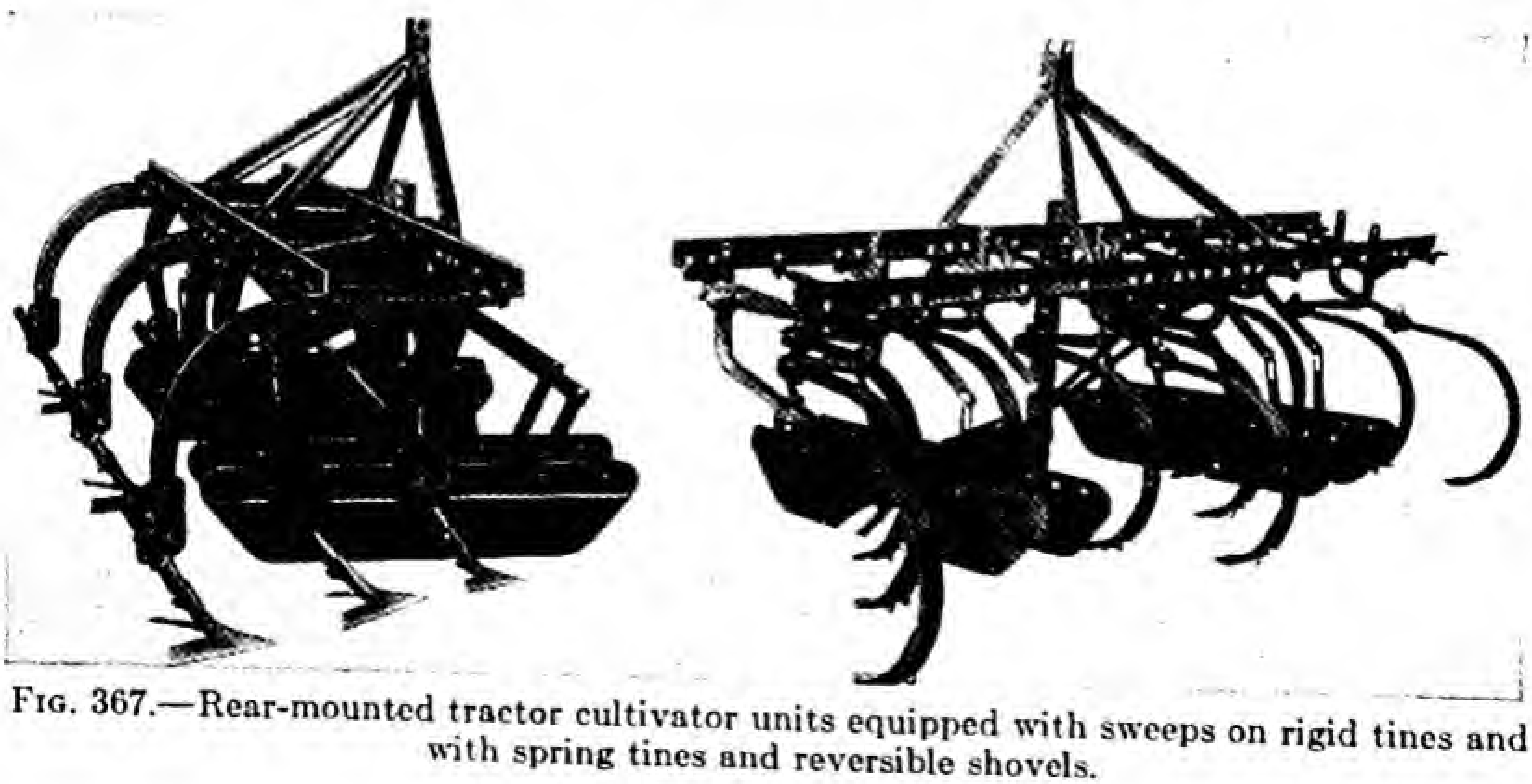


FIG. 367.—Rear-mounted tractor cultivator units equipped with sweeps on rigid tines and with spring tines and reversible shovels.

315. Four-row Tractor-mounted Cultivators.—Where the ground is level and large acreages are to be cultivated, a four-row tractor-mounted cultivator will materially reduce the man- and tractor-hours and the cost per acre. The cultivating gangs are mounted well forward on the tractor to facilitate steering. As the frame to which the gangs are attached must be long, gage wheels support part of the weight of each gang and gage the depth of penetration of the shovels or sweeps (Figs. 368, 369,

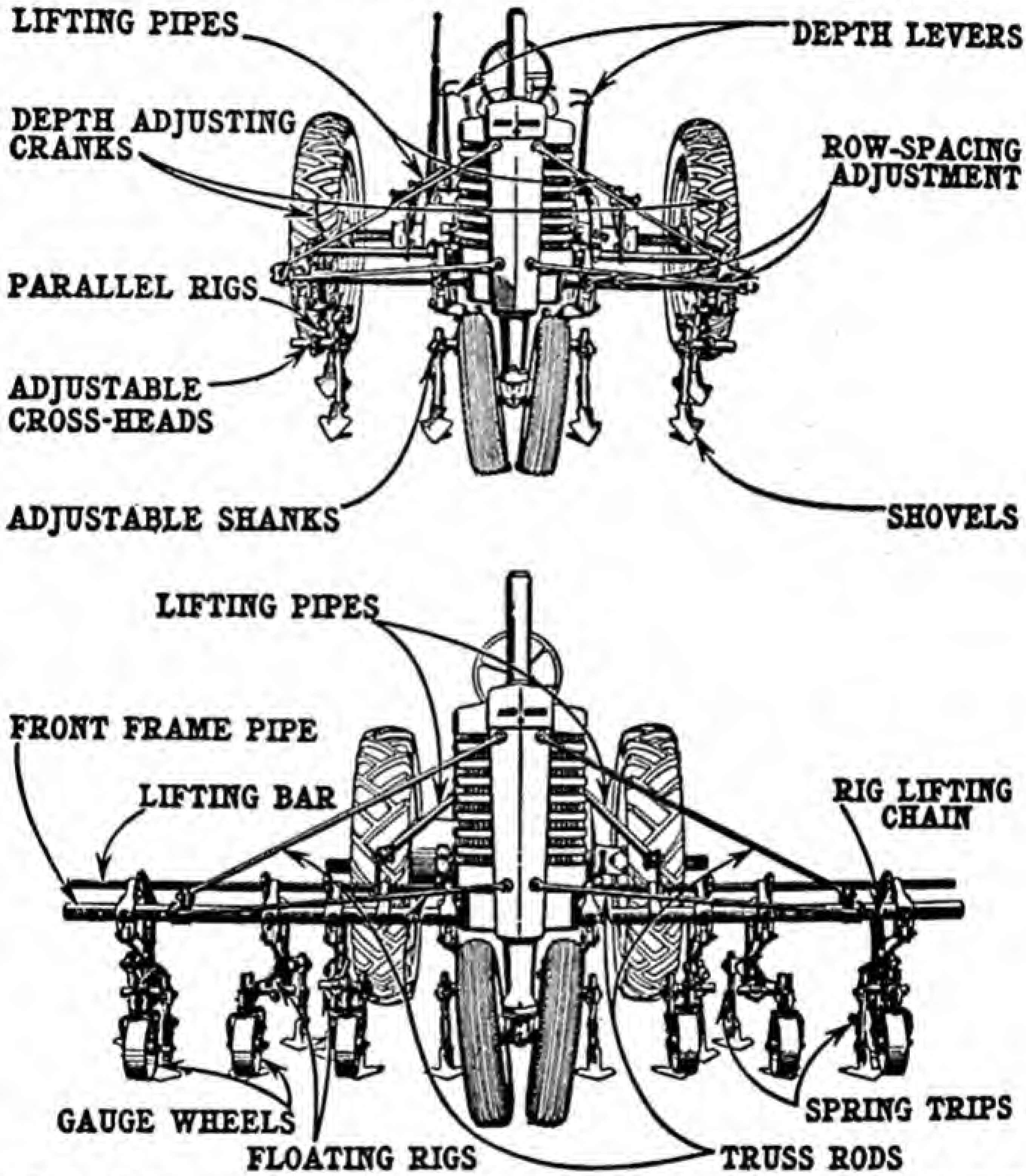


FIG. 368.—Two- and four-row tractor-mounted cultivators with parts named.

and 370). The gangs are lifted by mechanical and hydraulic power lifts (Fig. 371). No fertilizer attachments are used with four-row cultivators. Rotary hoe attachments can be used.

316. Attachments for Cultivators.—To save time and reduce the cost of operation, special attachments which function in connection with the cultivator have been developed.

The *fertilizer* attachment shown in Fig. 372 is popular for applying fertilizer as a side dressing. The fertilizer tube is connected behind the front shovel or sweep, (the shovel closest to the row) so that soil moved by a rear sweep will cover the fertilizer.

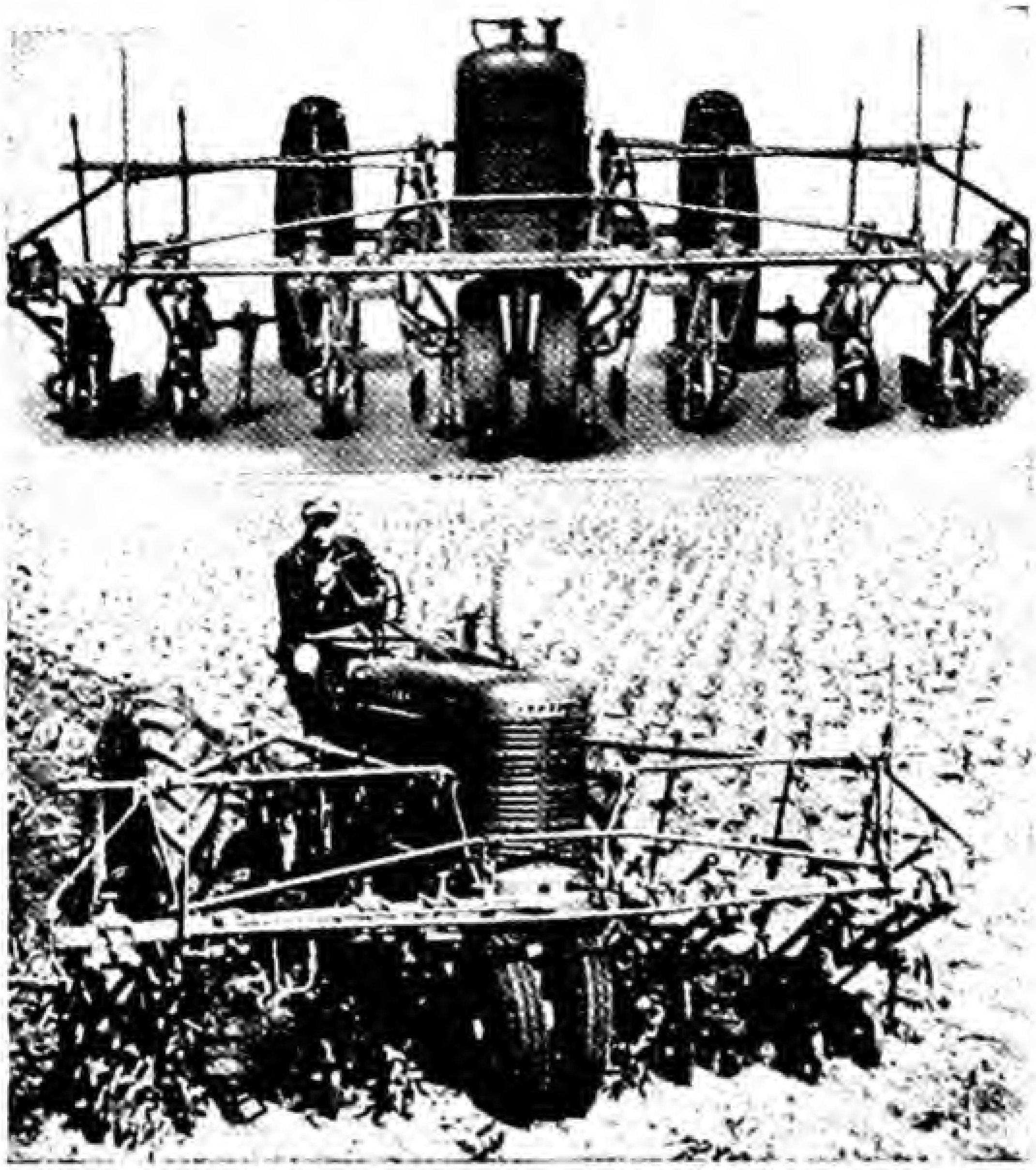


FIG. 369.—Showing mounting, parts, and operation of four-row tractor cultivator.

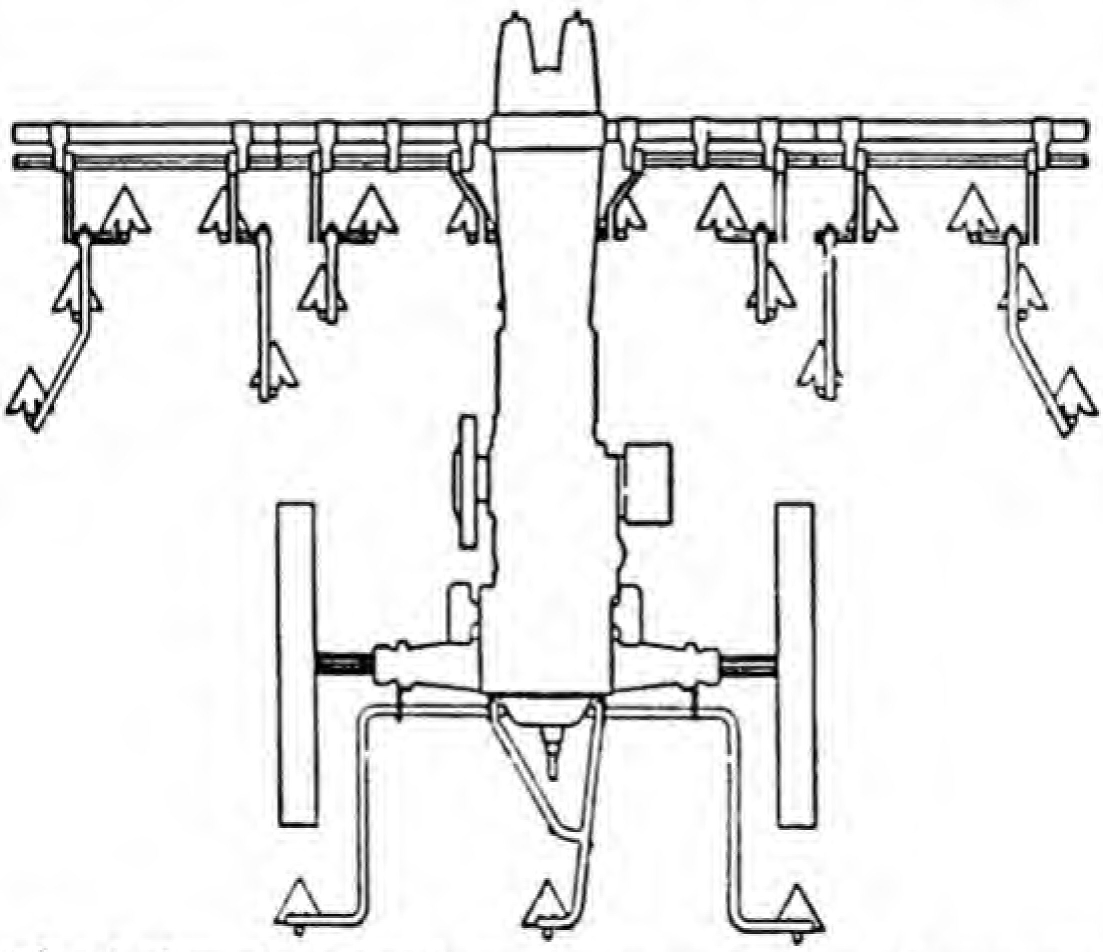
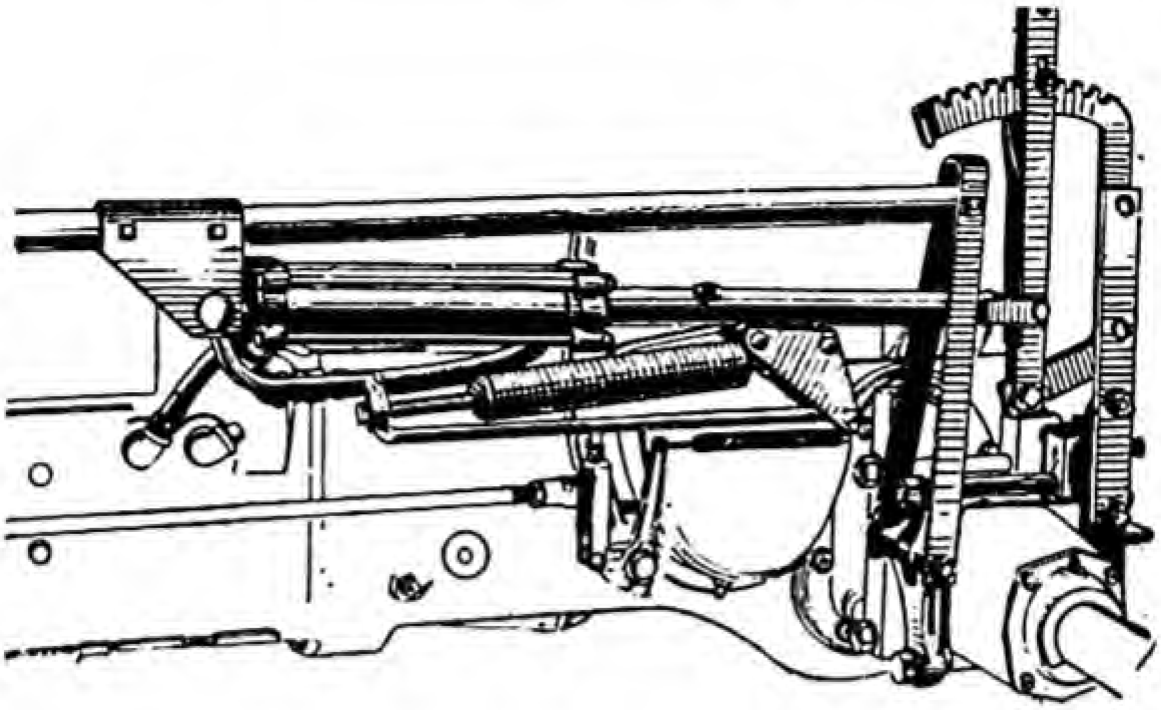


FIG. 370.—Overhead view of gang and sweep arrangement for a four-row tractor-mounted cultivator.

The *potato-hilling* attachment shown in Fig. 373 is used for hilling up potatoes.

A *disk-hiller* attachment is useful in trash and where there are morning-glory vines.



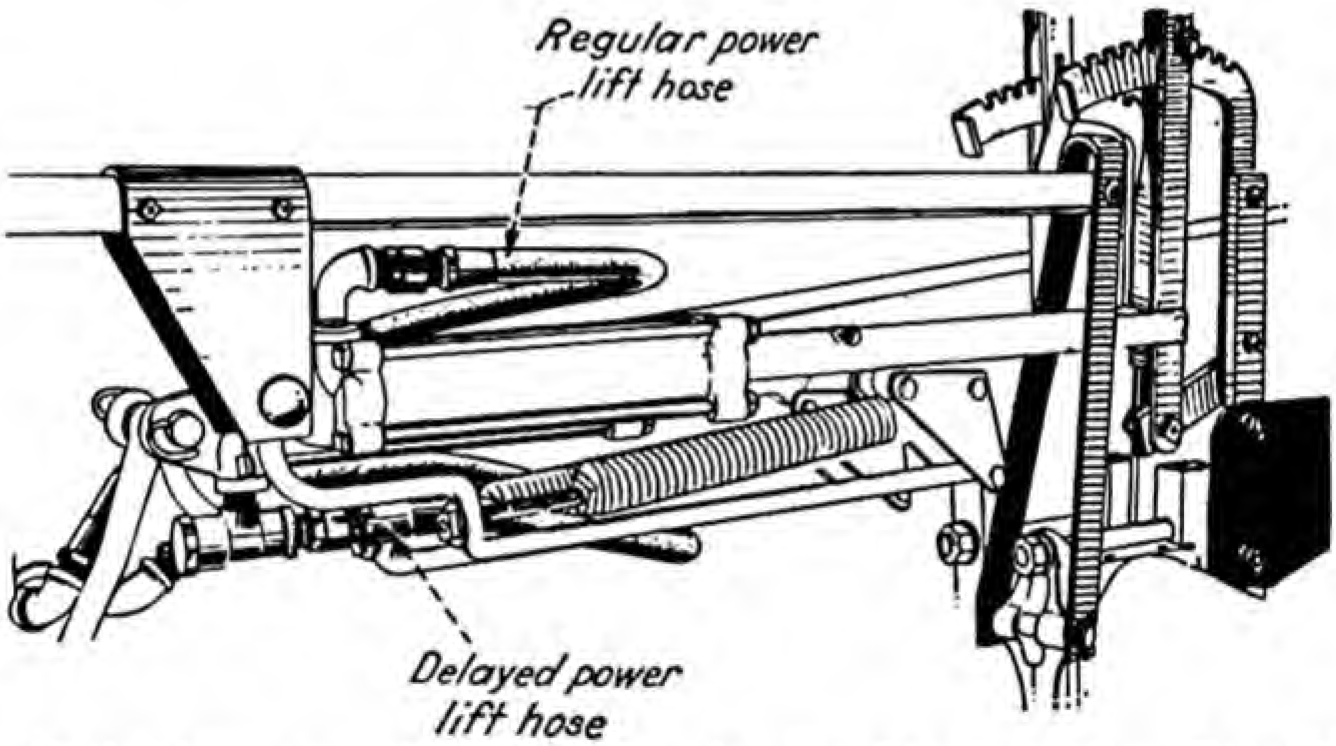


FIG. 371.—Hydraulic power lifts for front and rear cultivator units. *Top*, lift for front units; *Bottom*, delayed-action lift for rear unit.

FIG. 372.—Two-row cultivator fertilizer side-dressing attachment.

Three or four *rotary-hoe wheels* or *spiders* attached to and between the gangs so the wheels run over and stir the soil around young plants are an excellent attachment to control the growth of grass (Fig. 374). This also permits cultivation to be speeded up, as the wheels deflect

lumps and clods of soil but permit soil to shift through the wheels and fall around the plants without covering them.

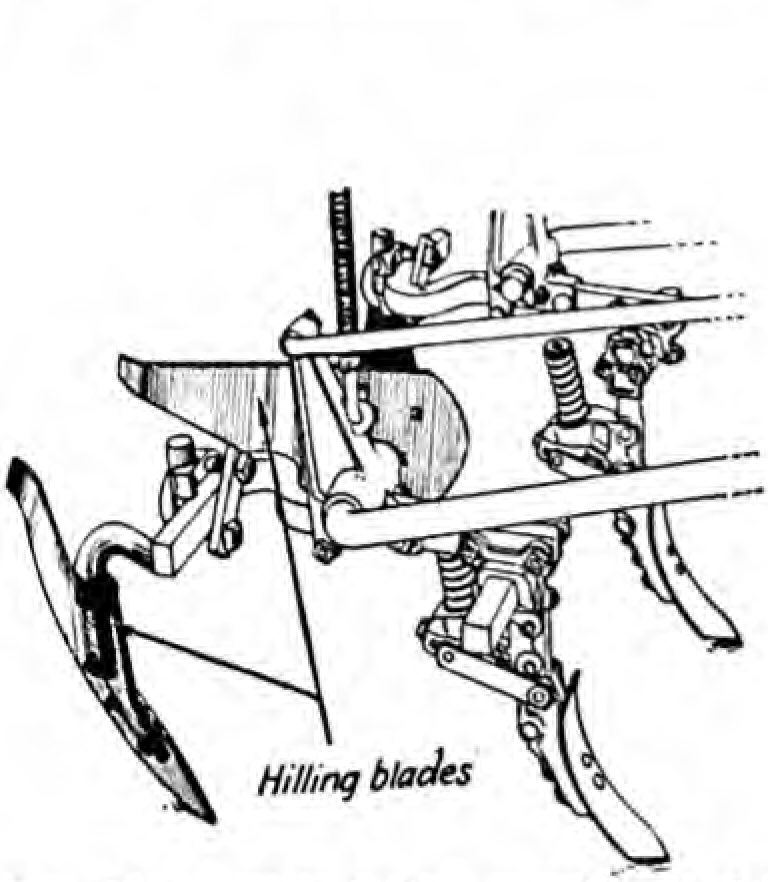


FIG. 373.—Potato-hilling attachment for tractor cultivator.

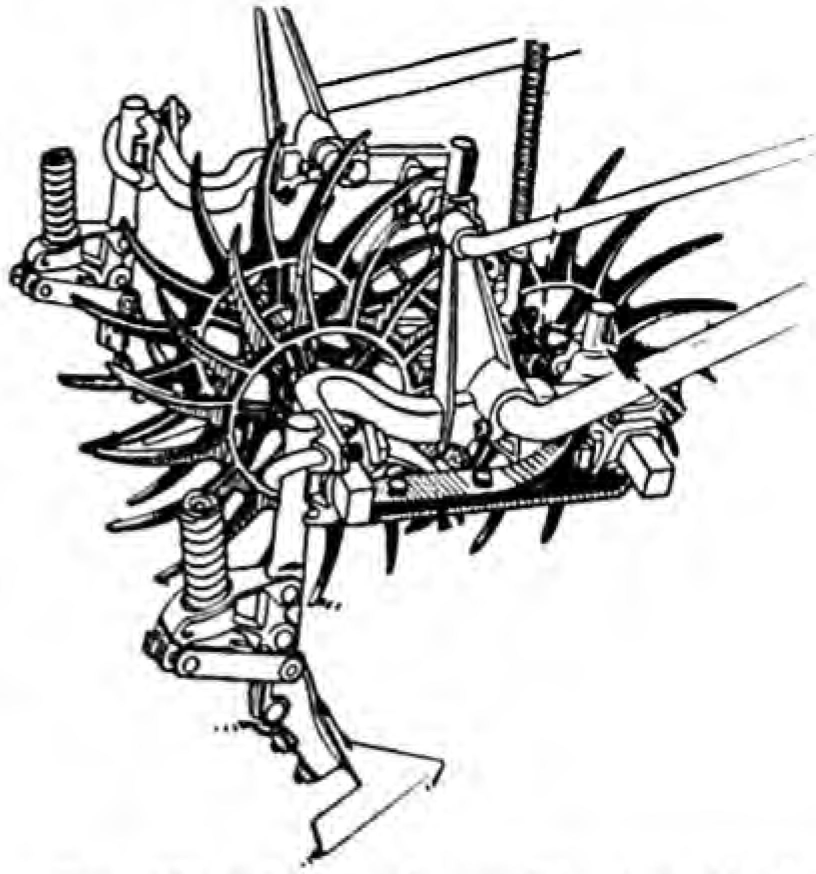


FIG. 374.—Rotary-hoe cultivator attachment used over the row between the cultivator sweeps.

The *peanut-digger* attachment shown in Fig. 544*a* is attached to the cultivator frame. Two or four rows can be dug at a time. Each of the

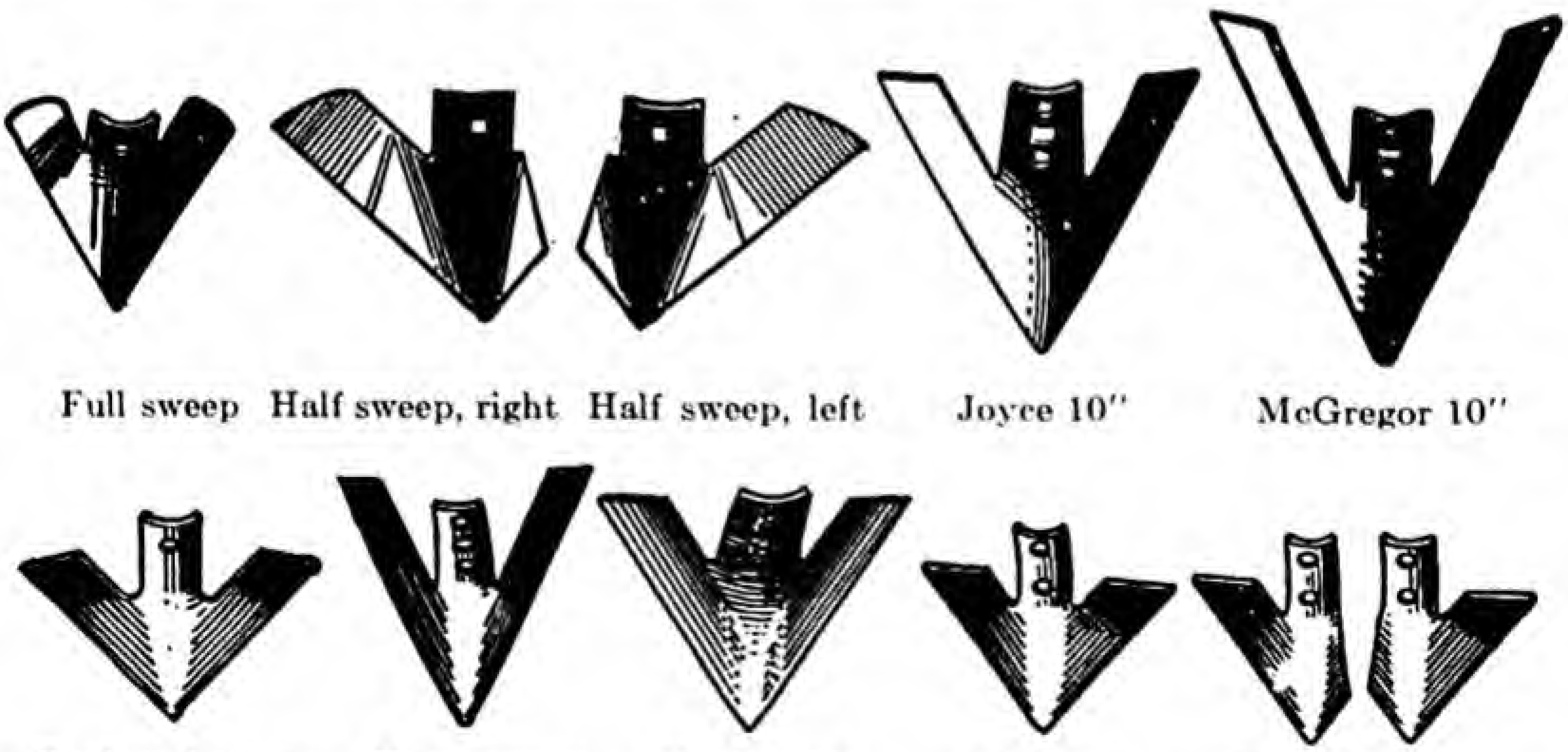


FIG. 375.—Types of sweep for cultivators.

long sharp knives runs under and cuts off the taproots and loosens the soil around a row of peanuts. By placing the knives as shown in Fig. 544*a* the two rows are partially thrown together or windrowed.

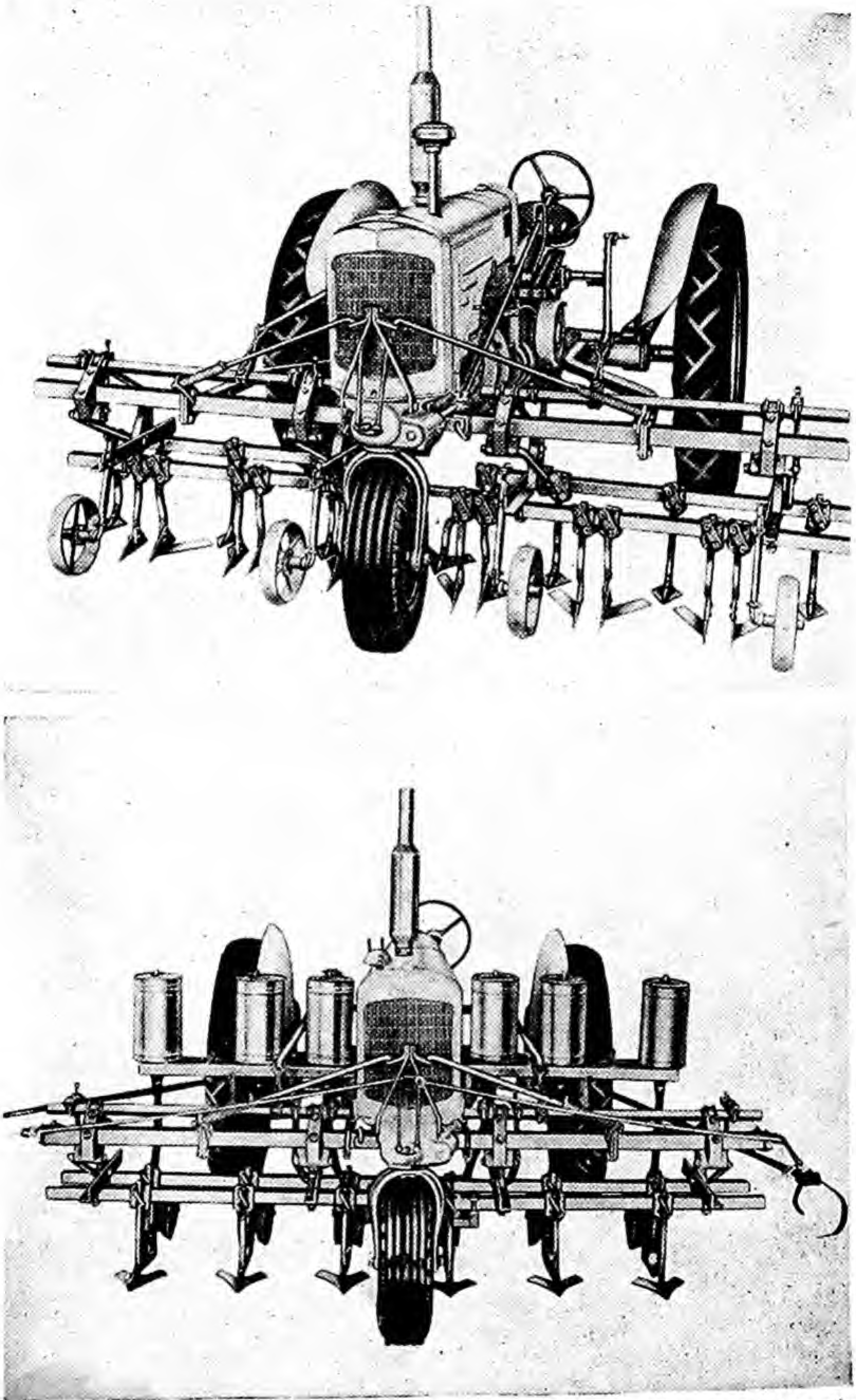


FIG. 376.—The six-row beet and bean cultivator (*top*) can be easily converted into a beet and bean planter (*bottom*).

SPECIAL CULTIVATING EQUIPMENT

In addition to the regular cotton and corn types of cultivating equipment, there are several types of cultivators designed for special crops and conditions.

317. Beet and Bean Cultivators.—Beets and beans are usually planted in more closely spaced rows than cotton and corn and require shovels and sweeps for shallow cultivation. Gage wheels control the depth of penetration of the shovels (Fig. 376).

318. Lister Cultivators.—Lister cultivators are particularly adapted to the cultivation of a listed crop in its early stages of development. Listed crops are those planted in the listed furrow or trench, or below the general level of the ground. There are four general types of lister cultivators: sled, wheel, two-row, and three-row.

319. Sled Lister Cultivator.—The sled cultivator is known in some localities as the *go-devil*. Figure 377 shows the complete outfit. It consists of two oak runners to which are attached crusher boards near the front end. Just back of these, on each side, are attached large side knives, to destroy weeds and level the middles. Gangs of disks are coupled to the rear arch. They can be raised and lowered and moved in and out. Each gang is composed of three steel disks, 10, 11, and 12 inches in diameter. They have wood bearings.

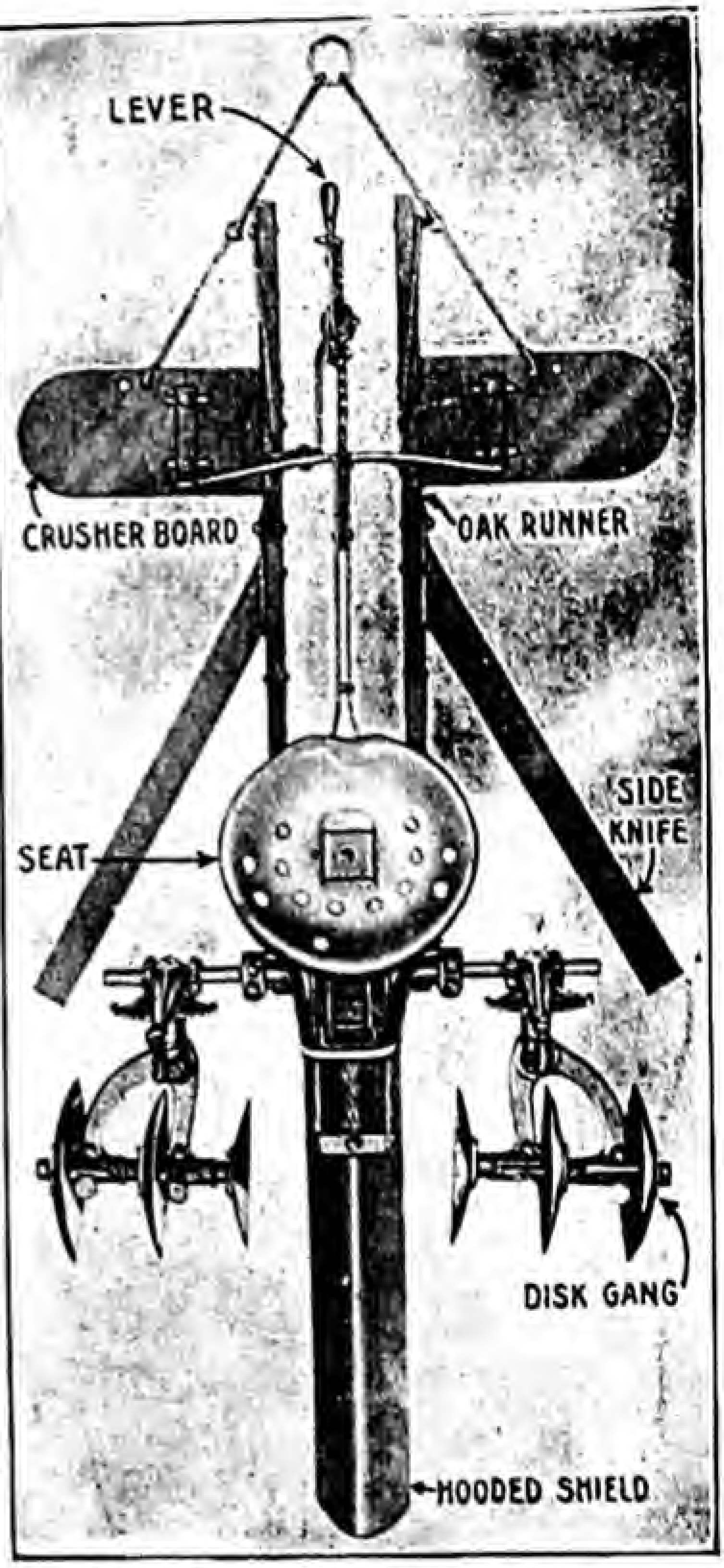


Fig. 377.—Sled lister cultivator.

320. Tractor-drawn Lister Cultivator.—The four-row tractor-drawn listed-furrow cultivator shown in Fig. 378 has wheels to support and guide the gangs for each row. For the first cultivation the disks are set to throw the soil away from the row of plants (Fig. 378). For all later cultivations the disks are set to throw the soil toward the plants.

321. Rod Weeders, Field Cultivators, Subsoil, and Chisel Cultivators. These cultivators are generally used to control weed growth on fallow lands and are discussed as Seedbed Preparation Machinery.

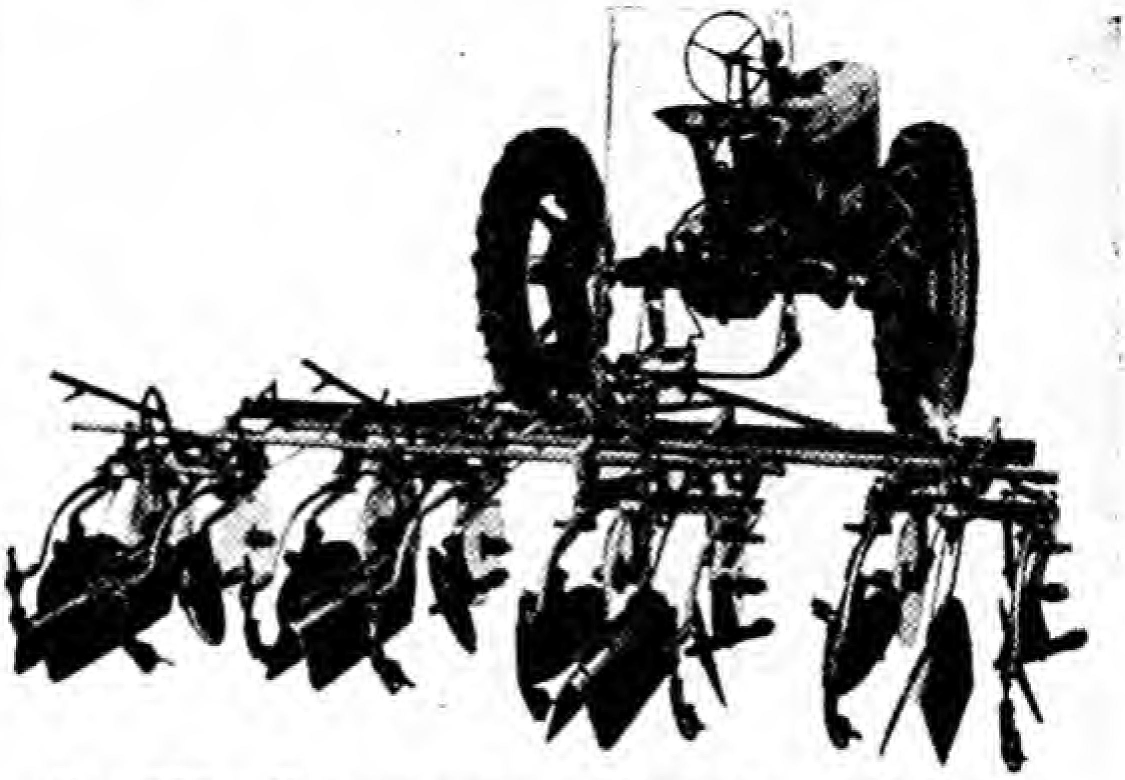


FIG. 378.—Four-row tractor-drawn lister cultivator.

322. Rotary Hoe.—The rotary hoe is a cultivating implement to cultivate and destroy weeds and grass around young plants. When rains cause a hard crust to form over the soil and hinder the emergence of young seedlings, the rotary hoe is an excellent tool for pulverizing the crust. The tool can be used to advantage in young corn, cotton, soybeans, potatoes, and small grains.

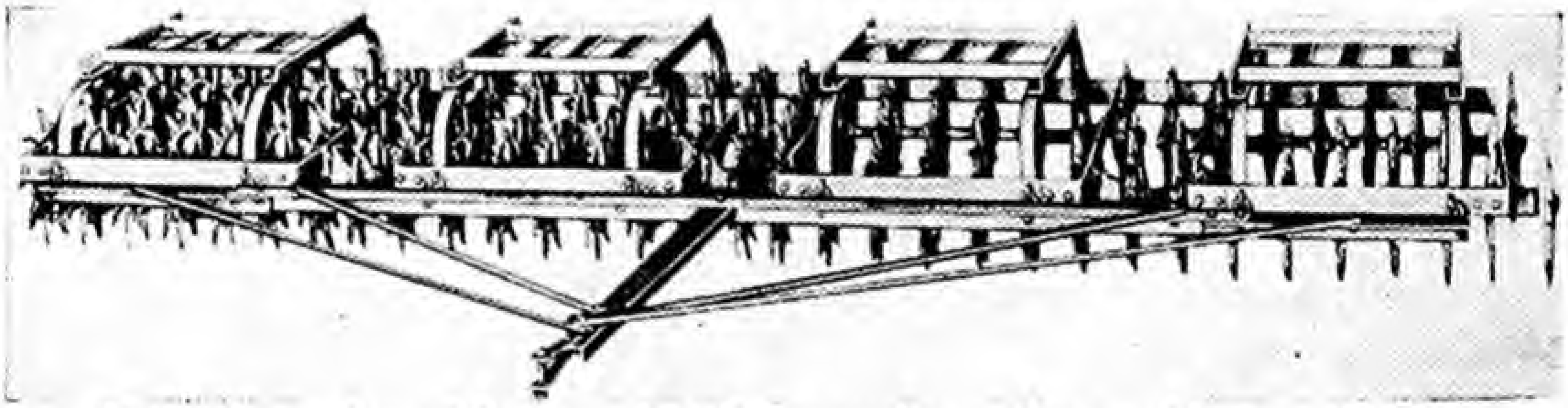


FIG. 379.—Front view of four-row flexible rotary hoe. Note weight-carrying frames on each section.

FIG. 380.—Four-row rotary hoe being used on small corn.

The rotary hoe is made up of two gangs of hoe wheels. One gang is placed behind the other and the wheels are spaced so that the wheels of the rear gang extend forward between the wheels of the front gangs. Some two- and three-row units have solid axles (Fig. 382), while the larger units for tractor use are made up in sections so that each section can follow the contour of the soil (Fig. 380). The hoe wheels or spiders are usually made of malleable cast iron, but made-up steel wheels are also available (Fig. 381).

Two to three units can be hitched squadron fashion as shown in Fig. 382.

Rotary hoes should be used at fairly high rates of speed. Good work can be done under some conditions at 10 m.p.h. If the plants are large

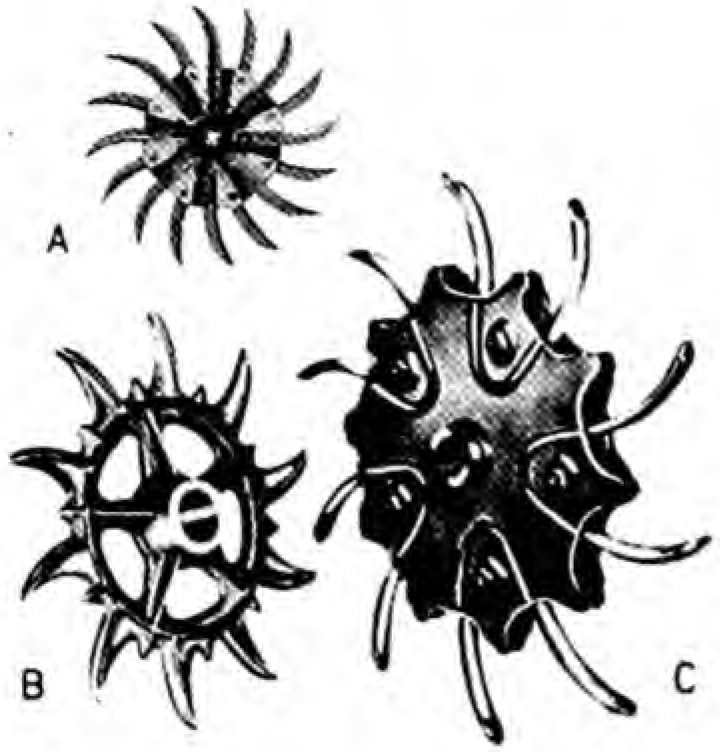


FIG. 381.—Three rotary-hoe wheels or spiders. *A*, all-steel wheel with spokes riveted on alternate sides; *B*, malleable cast-iron wheel; *C*, oval-tooth steel wheel. The teeth are clamped between two steel plates.

there is a tendency for the spokes to catch the foliage and pull up a few plants.

When the rotary hoe is run backward or with teeth reversed, it makes a useful tool as a "treader" to tread down heavy stubble and other crop

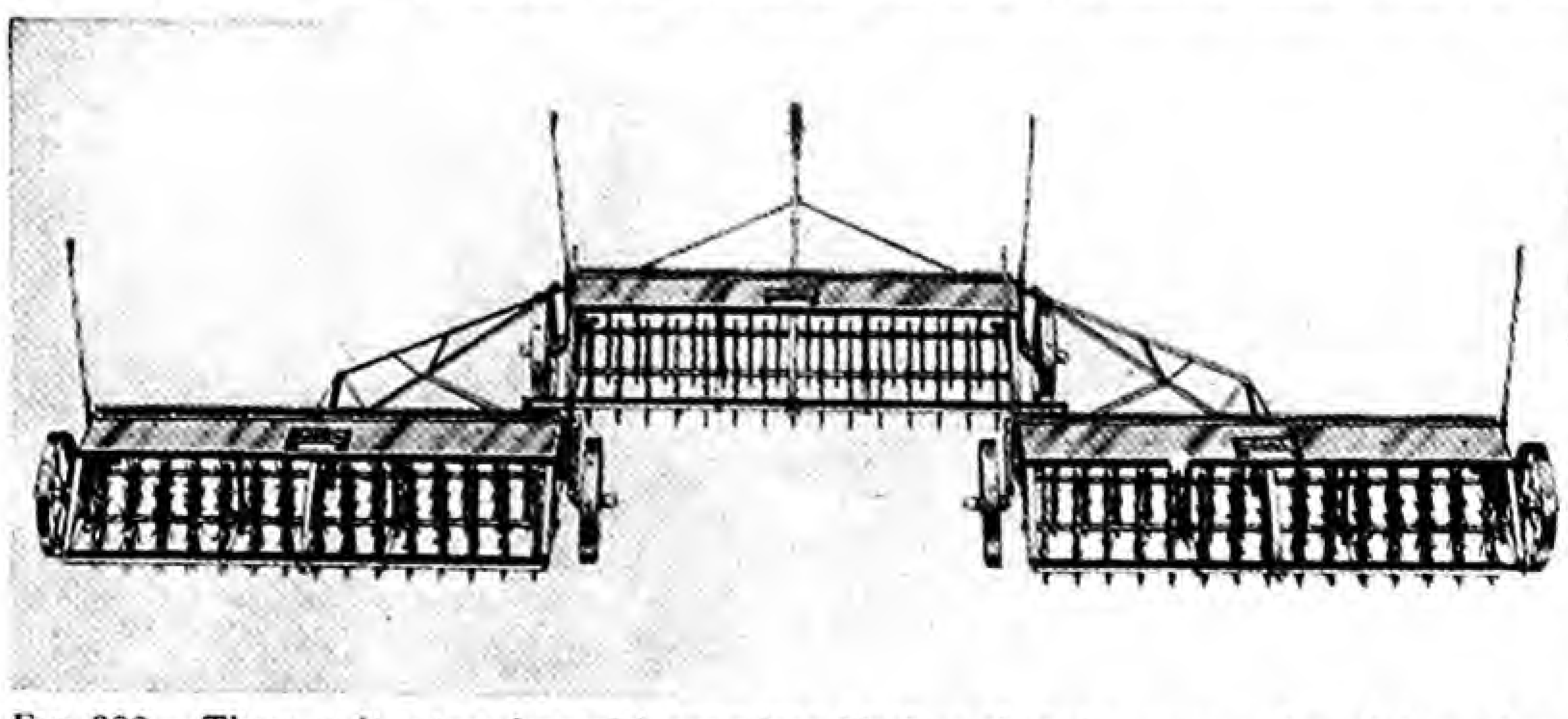


FIG. 382.—Three-unit rotary hoe with squadron hitch so that six rows can be cultivated at a time.

residues without clogging. It tears apart large clods, packs the soil from below, and at the same time treads the seed into the clean, firm seedbed through the protective residue which may be on the surface. It may be a good broadcast seeder when a seeder box is attached.

323. Plant-thinning Machines.—When the seeds of cotton, beets, and other crops are drilled thick along the row to get good stands, it is necessary that the plants be thinned to obtain the best yields. A popular tool for thinning cotton is shown in Fig. 383*a*. The cutterhead or thinning

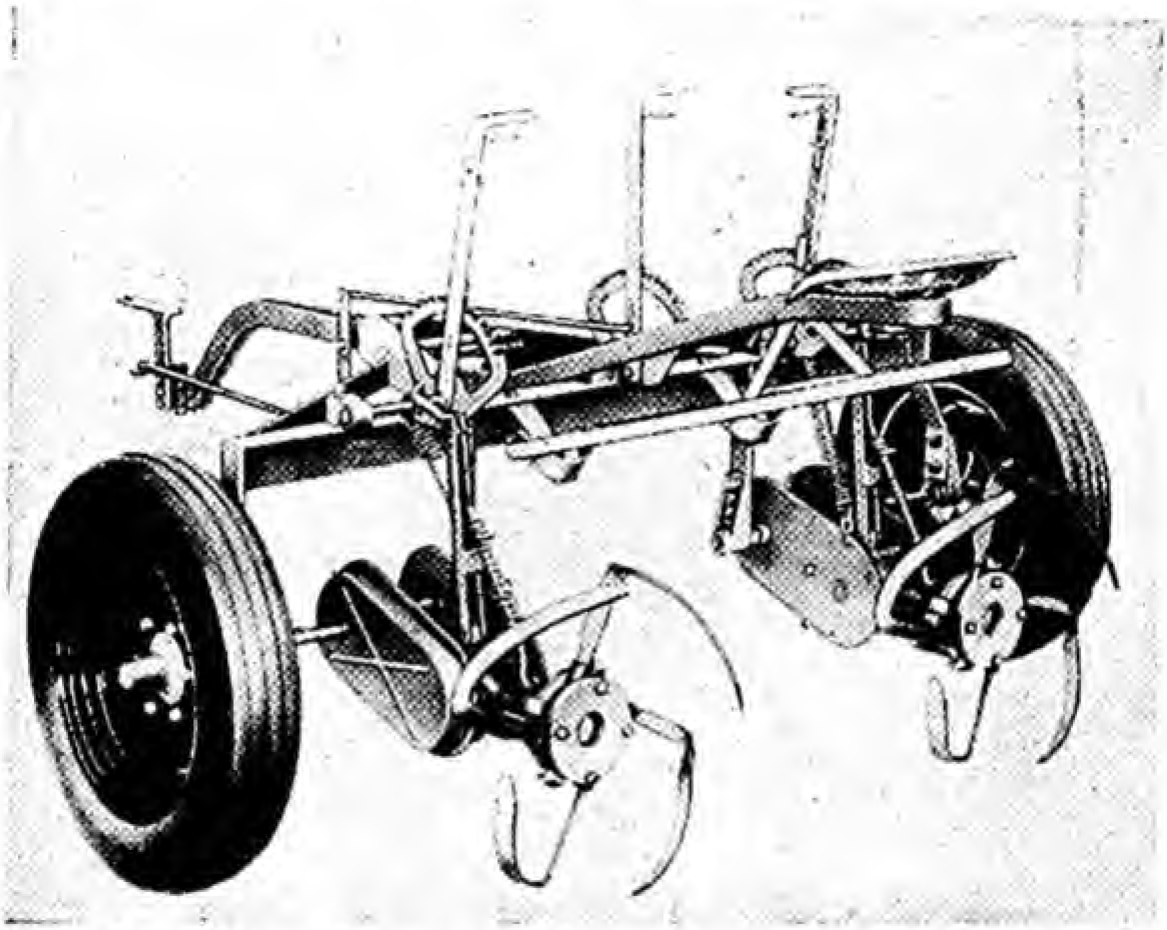


FIG. 383*a*.—Rear view of two-row plant thinner showing knife cutterhead.

unit consists of four knives clamped in a hub. The knives can be turned and adjusted to leave an uncut space along the row from 1½ to 5 inches (Fig. 384). Different-sized sprockets are provided to vary the speed of the cutterhead and the spacing of the hills. Single and two-row trailing machines are made. Figure 385 shows three two-row machines hitched

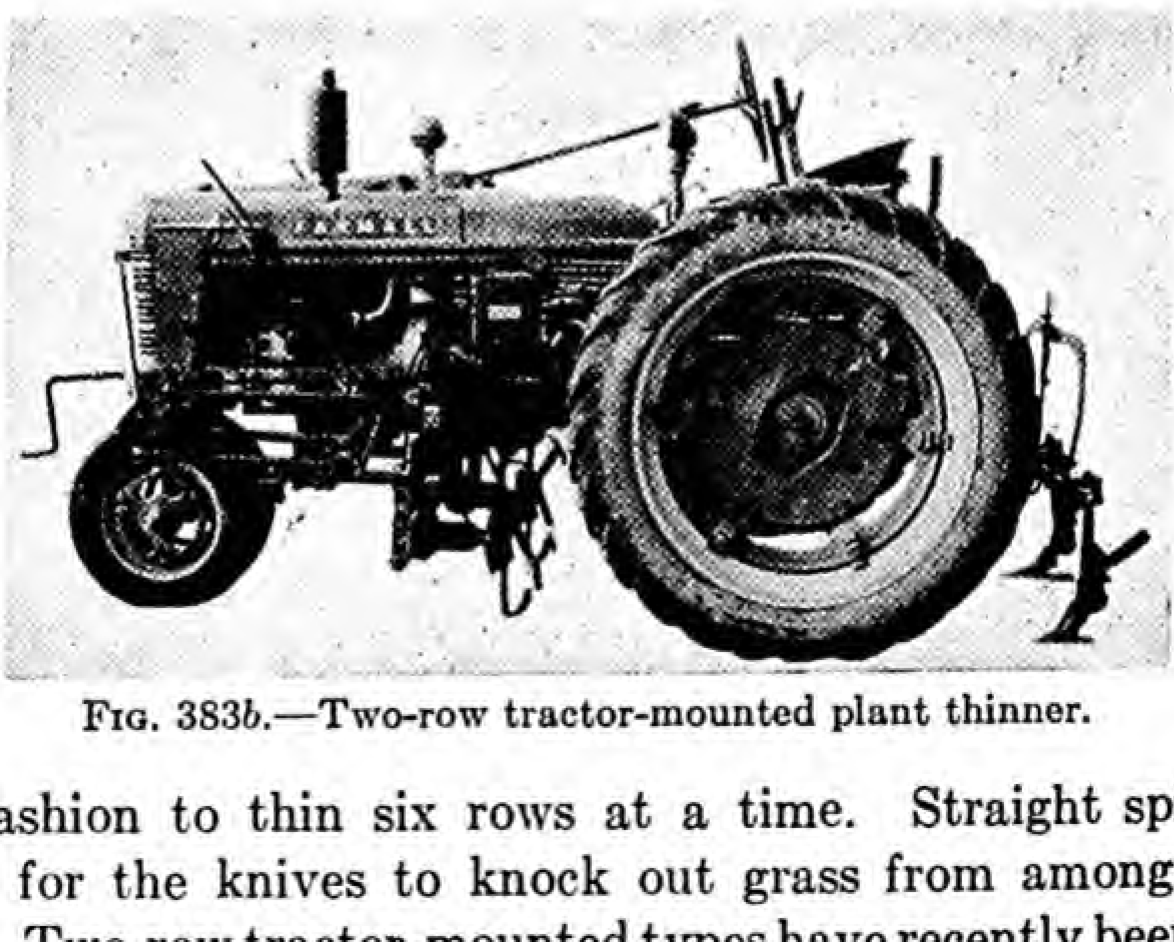


FIG. 383*b*.—Two-row tractor-mounted plant thinner.

squadron fashion to thin six rows at a time. Straight spikes can be substituted for the knives to knock out grass from among the plants (Fig. 386). Two-row tractor-mounted types have recently been developed (Fig. 383*b*).

Another type of plant thinner has hoelike blades that chop straight across the row.

Plants also are thinned and blocked by the use of sweeps set flat and run at right angles or across the row. This is called *cross plowing.*

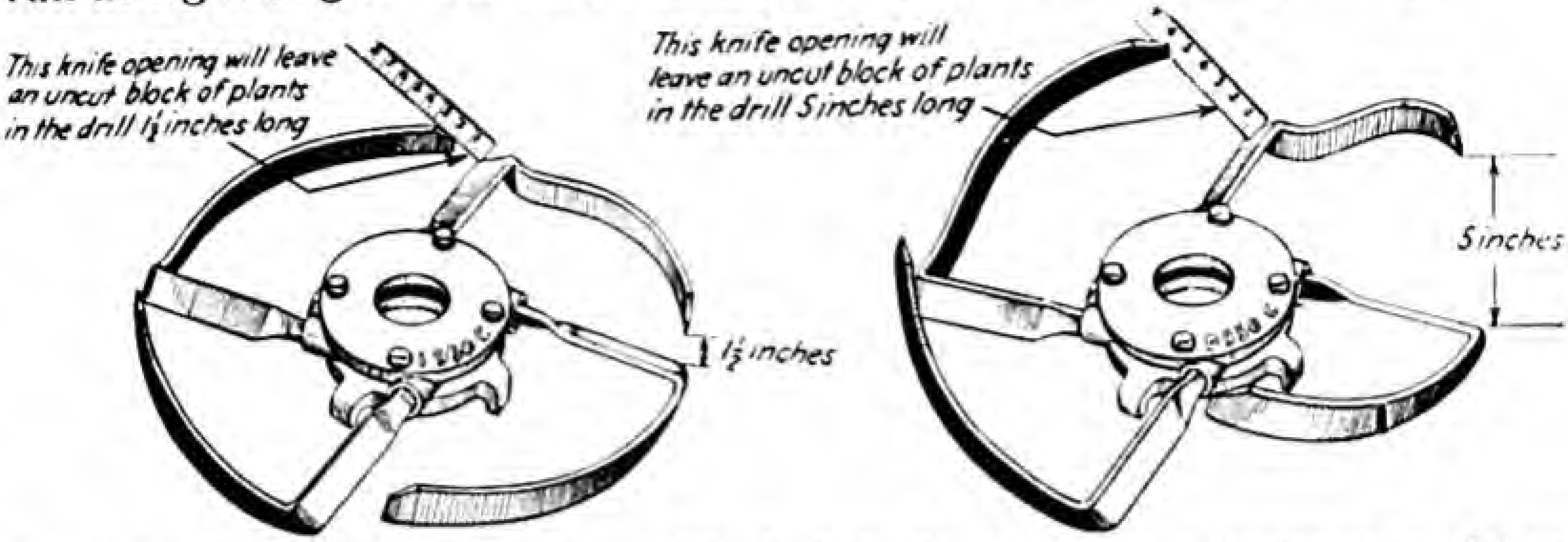


FIG. 384.—The space between toe and heel of the blades can be adjusted from 1½ to 5 inches.

324. Flame Cultivation.—Flame to kill weeds has been used by railroads for many years. It has also long been used by ranchmen to burn the spines off cactus so that livestock could graze on the cactus during long droughts. The use of flame for the control of grass and weeds among row-crop plants is a comparatively new development. The equipment consists of a fuel tank, feed lines, control valves, and burners. The system is mounted

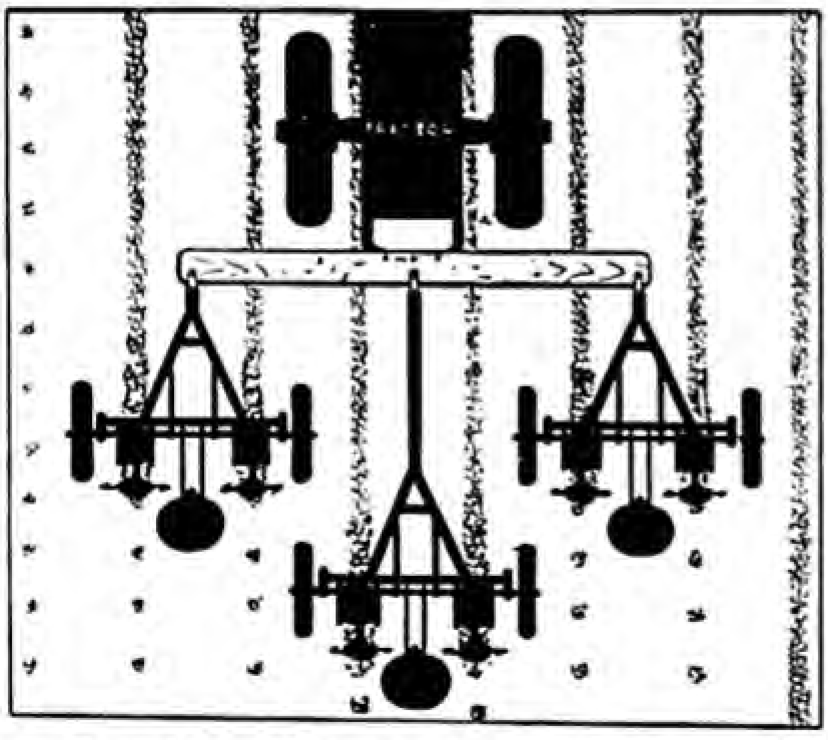


FIG. 385.—Three two-row plant-thinning machines hitched squadron-fashion to thin six rows.

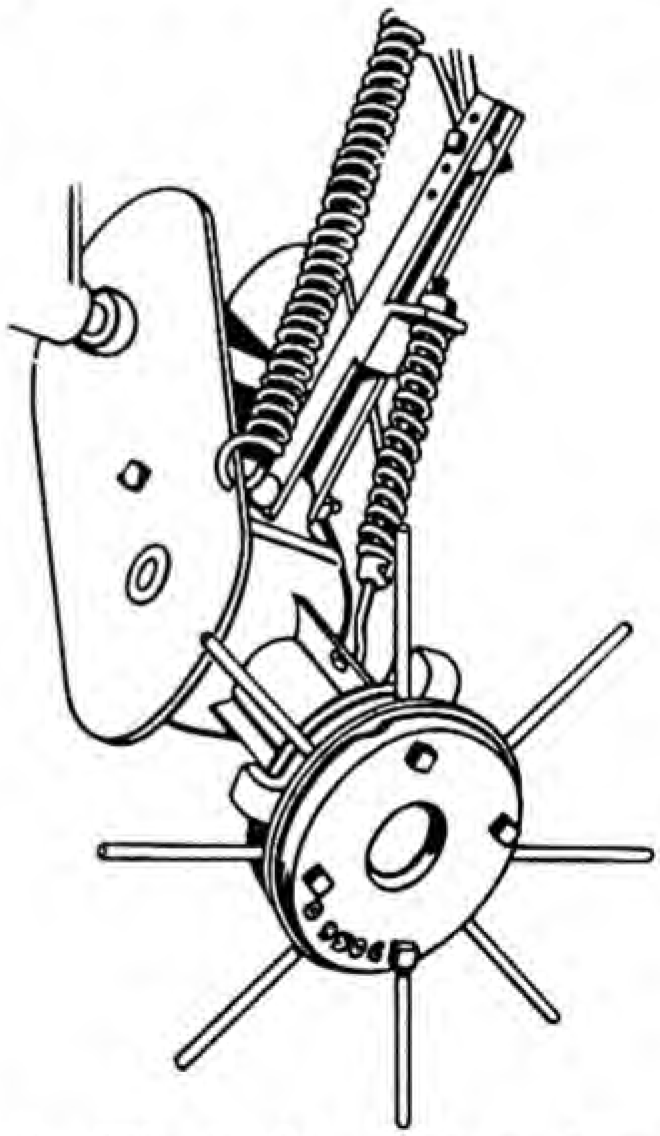


FIG. 386.—Spoke wheel used to cultivate plants.

on a tractor with skid supports for the burners (Fig. 387). Burners are provided for each side of each of two to four rows; a two-row system requires four burners and a four-row system requires eight

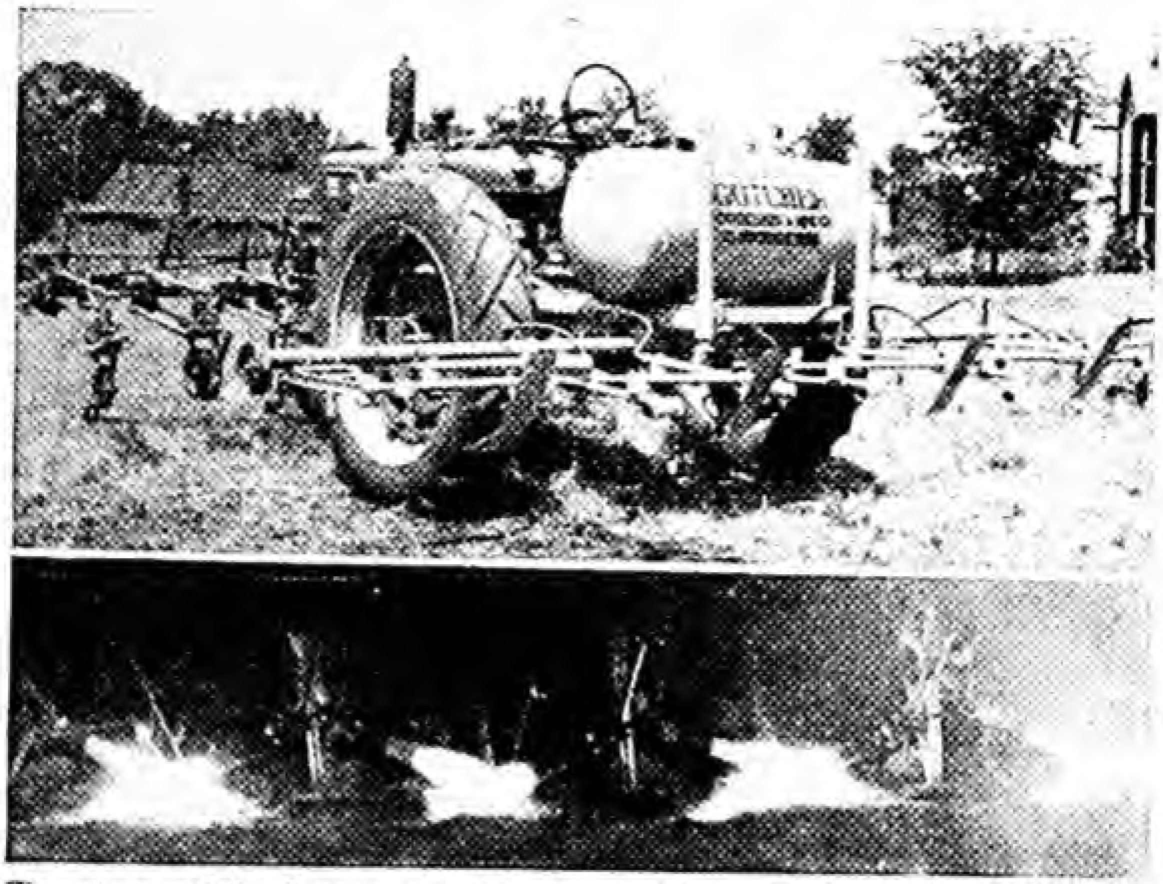


FIG. 387.—Tractor with flame-cultivator unit mounted on rear to flame weeds and grass in the crop row and a cultivator unit in front to cultivate the middles between the rows. *A*, night view of the burners in operation, is shown below.

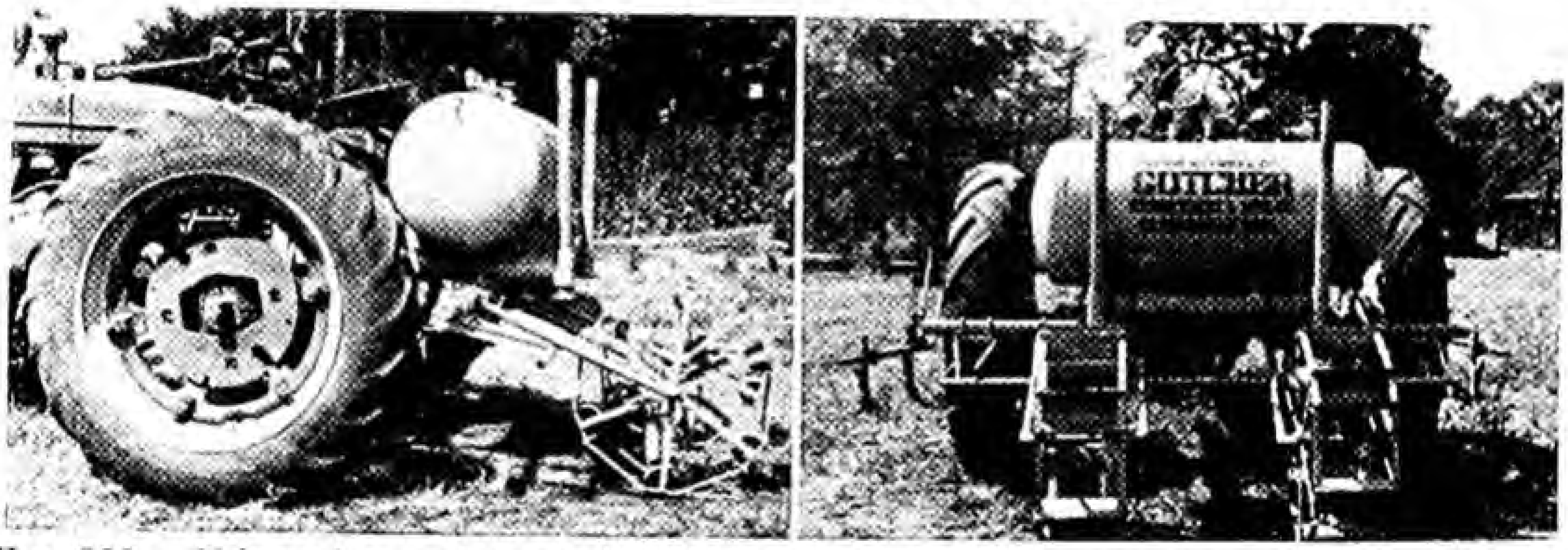


FIG. 388.—Side and rear view of plant-blocker wheel and cups for flame blocking of plants.

FIG. 389.—Hand flame gun.

burners. The burners are mounted so that they will direct a hot blue flame close to the ground on the grass among the plants. Plants to be cultivated should be tougher and larger than the grass and weeds to be destroyed. The burner is provided with both vertical and

horizontal adjustments. Plants can be thinned by mounting cylinders in wheels and placing them to run over the row and protect plants. Plants not protected are subjected to the hot flame and are killed (Fig. 388).

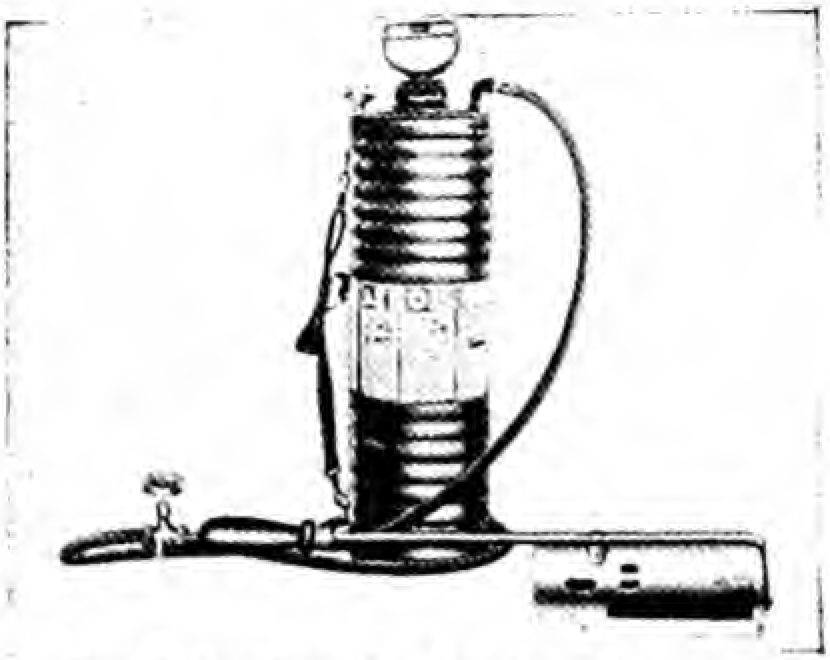


FIG. 390.—Portable hand weed burner.

Early models used kerosene for fuel, but later models use butane and propane gas.

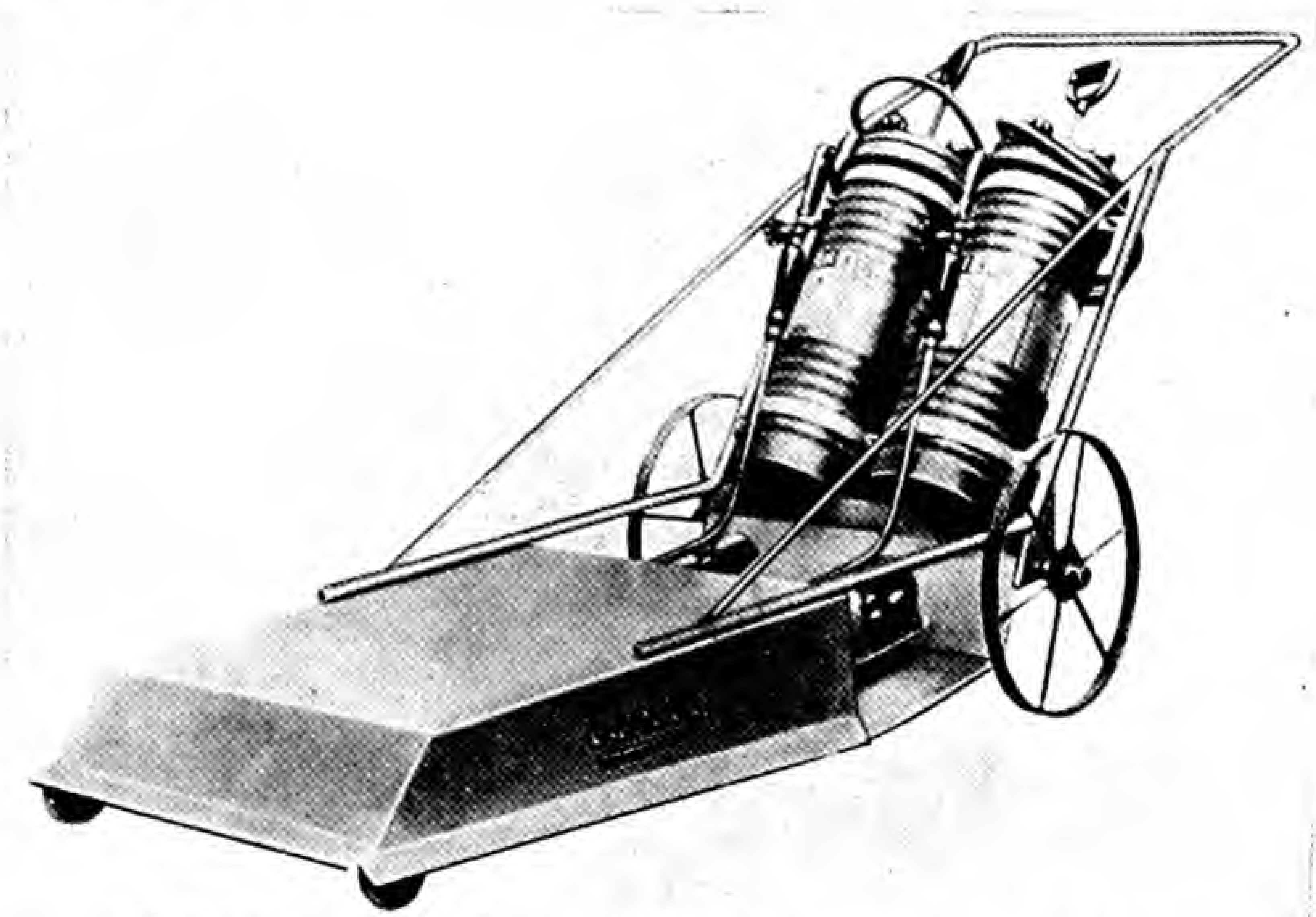


FIG. 391.—Two portable burners arranged for broadcast burning of weeds.

325. Brush and Weed Burners.—Various sizes of weed and brush burners can be obtained for the burning of weeds and brush about the farmstead (Figs. 389, 390, and 391). Burners mounted on long booms are used for the burning of weeds in ditches and canals.

PART VII
DUSTING AND SPRAYING MACHINERY

CHAPTER XIX

DUSTING AND SPRAYING EQUIPMENT

The problem of controlling insect pests and plant diseases makes it necessary for a large percentage of farmers and orchardists to include in their farm equipment machines for applying either dust or liquid insecticides and fungicides. It is estimated that insect pests and plant diseases cause an annual loss of several million dollars.[1] In addition to these losses there is the cost of purchasing spraying equipment and material, maintaining the equipment, and applying sprays and dusts.

The selection of the proper equipment to combat a certain insect pest or plant disease is a problem that needs careful consideration.

DUST SPRAYERS

Many insects and plant diseases can be controlled more effectively and economically with dusts than with liquid sprays. Thousands of acres of cotton are annually dusted with calcium arsenate to control the boll weevil and leaf worm. Potatoes and other field crops, as well as garden and orchard crops, are dusted with various kinds of insecticides and fungicides. Dusts may be applied with hand dusters, traction dusters, power-take-off dusters, engine-powered dusters, and airplanes.

Fig. 392.—Hand dusters.

326. Hand Dusters.—The small hand-pump dusters shown in Fig. 392 are useful where only a few vegetables or flowers are to be dusted. The special nozzle on the extension tube is for dusting upward from beneath plants and vines. The crank duster (Fig. 393) is used where

[1] *Agr. Eng.*, Vol. 17, No. 1, p. 13, 1936.

FIG. 393.—Hand-gun duster.

small areas of plants are dusted. The duster is provided with both single and double nozzles. The fan for blowing the dust is driven by a chain, and speed is obtained by gears. A saddle duster is shown in Fig. 394. The outfit is placed on a mule or horse so that the operator may ride and dust a row on each side.

FIG. 394.—Saddle-gun duster.

327. Horse-drawn Ground-driven Dusters.—A small one-mule two-row cotton duster is shown in Fig. 395. The nozzles extend back behind the operator, who walks and guides the machine, turning it at the ends. The large wheel furnishes power for driving the agitators and fan.

In most two-wheel machines the axle is adjustable for rows of different width and is arched to a height sufficient to clear the plants. Straight axles are used on machines for dusting potatoes and other low-growing crops. For cotton only one nozzle is required for each row dusted, but for some crops two nozzles are required.

328. Power-cart Duster.—This machine has a gasoline engine mounted on the platform to furnish power to operate the dusting mecha-

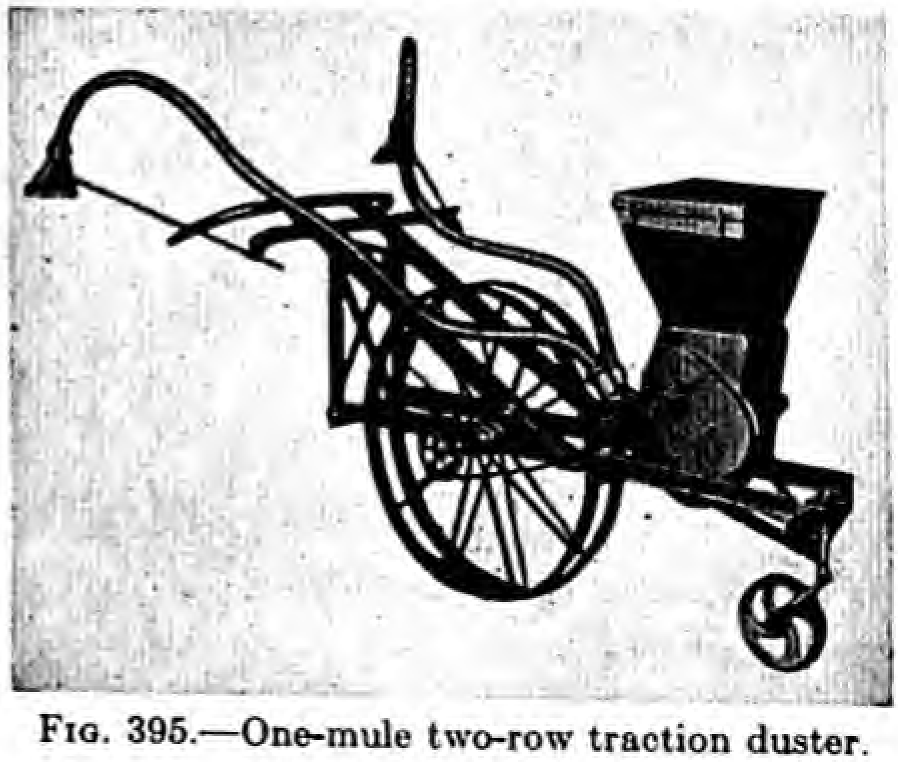


FIG. 395.—One-mule two-row traction duster.

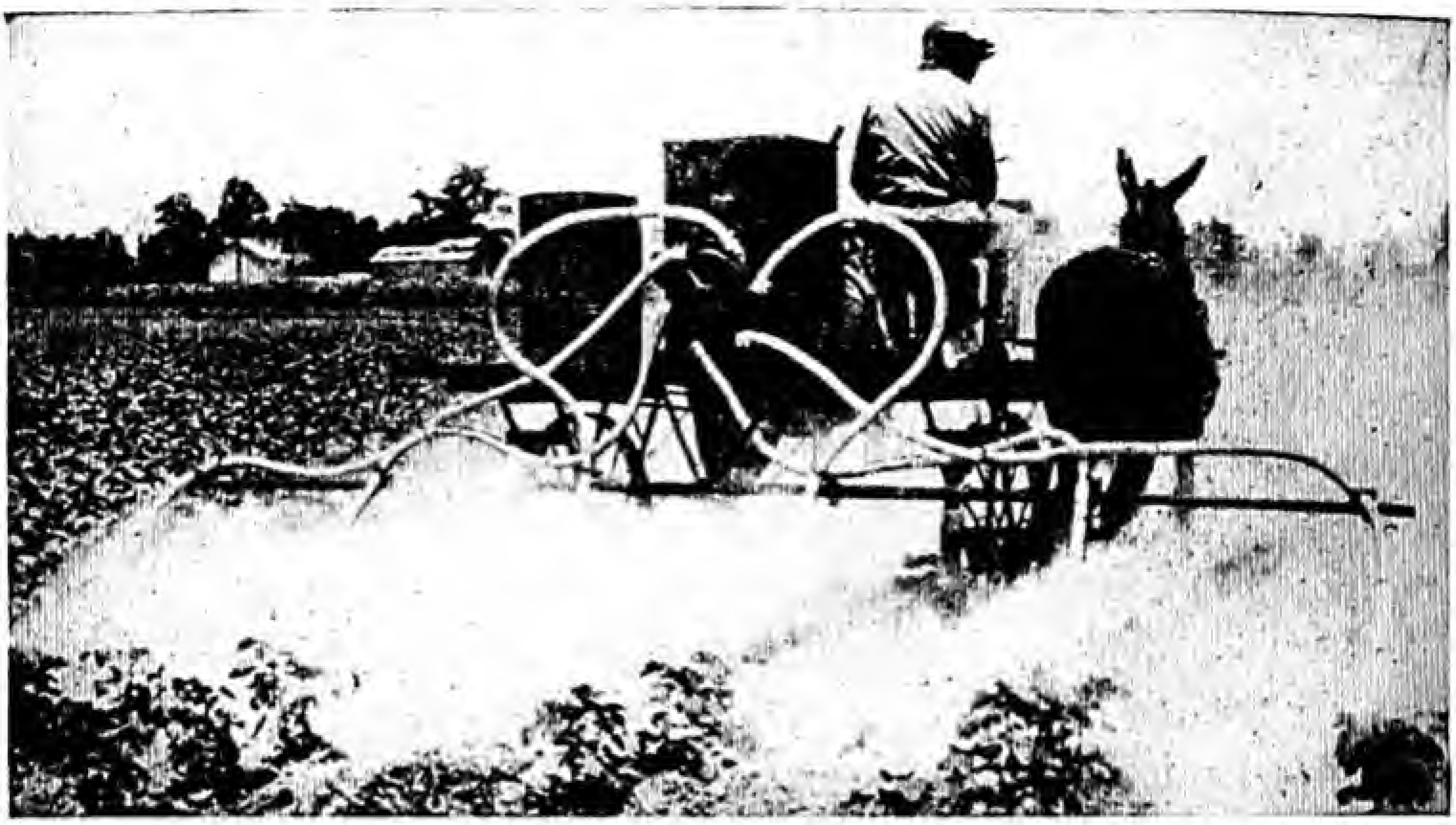


FIG. 396.—Rear view of power-cart duster dusting young cotton.

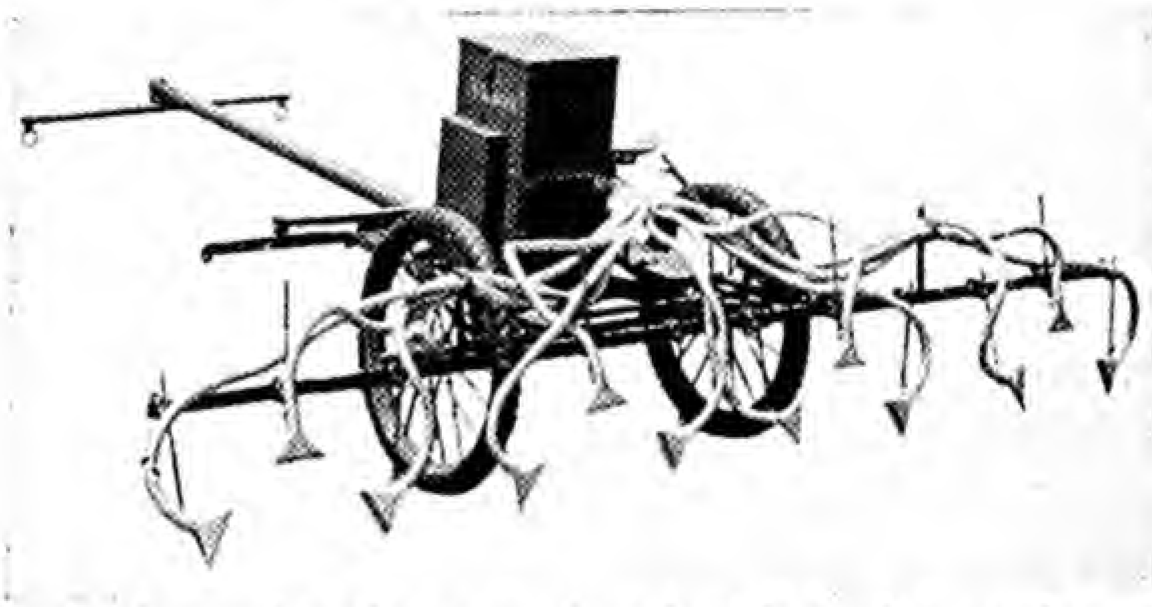


FIG. 397.—Two-wheel traction duster equipped with twelve nozzles, suitable for the dusting of potatoes and vegetable crops.

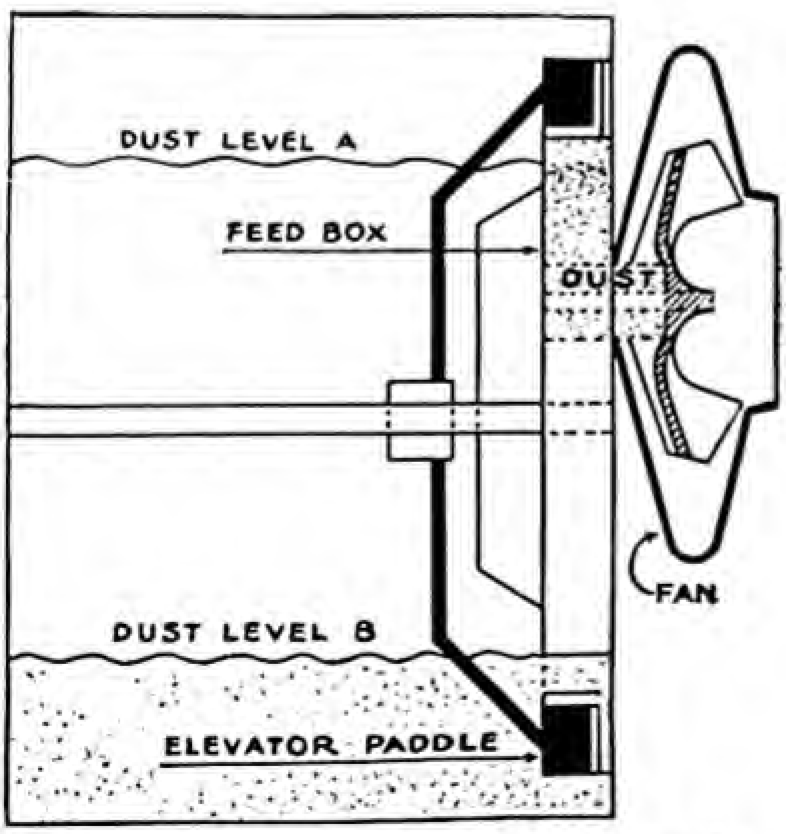


FIG. 398.—Cross section of elevating feed for duster.

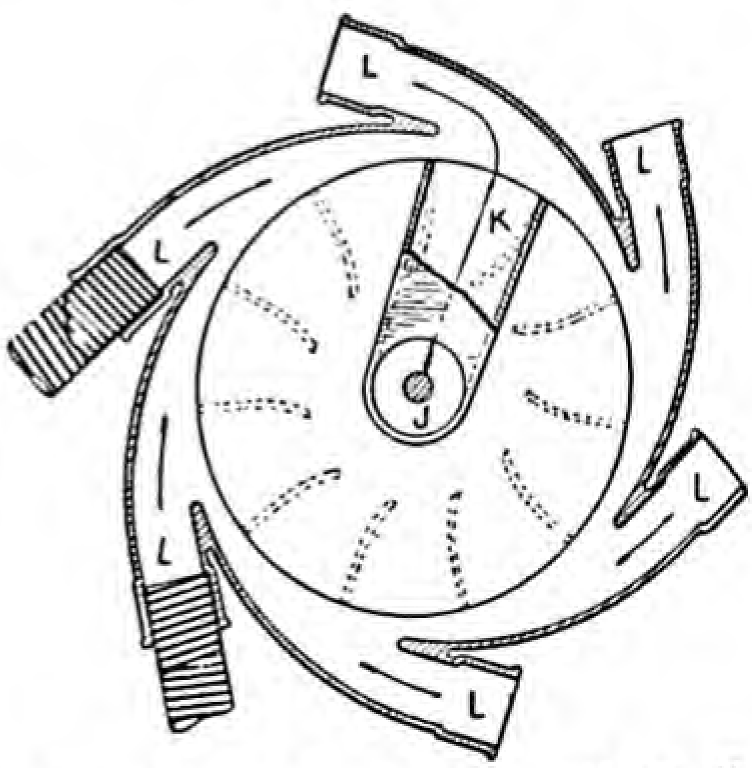


FIG. 399.—A sectional view of centrifugal discharge fan and fan housing.

nism (Figs. 396 and 397). The engine furnishes power to produce a sufficient velocity of air to break up and separate the dust particles into a fine foglike mist, which is distributed uniformly over the plants. Nozzles can be installed to dust up to ten rows of plants.

Power-dusting units consisting of a complete dusting machine and engine mounted upon a suitable base ready for operation are available. These units can be mounted upon any homemade cart or truck.

329. Tractor-powered Field Dusters.—Figure 400 shows a dusting unit mounted upon a platform bolted to the rear of a tractor and operated

FIG. 400.—Six-row tractor-mounted and power-take-off-driven cotton duster.

by the power-take-off. Operating the tractor in high gear makes it possible to dust a larger acreage than with horse-drawn machinery of equal row capacity. Auxiliary engines are used on some tractor-mounted dusters to obtain more uniform power.

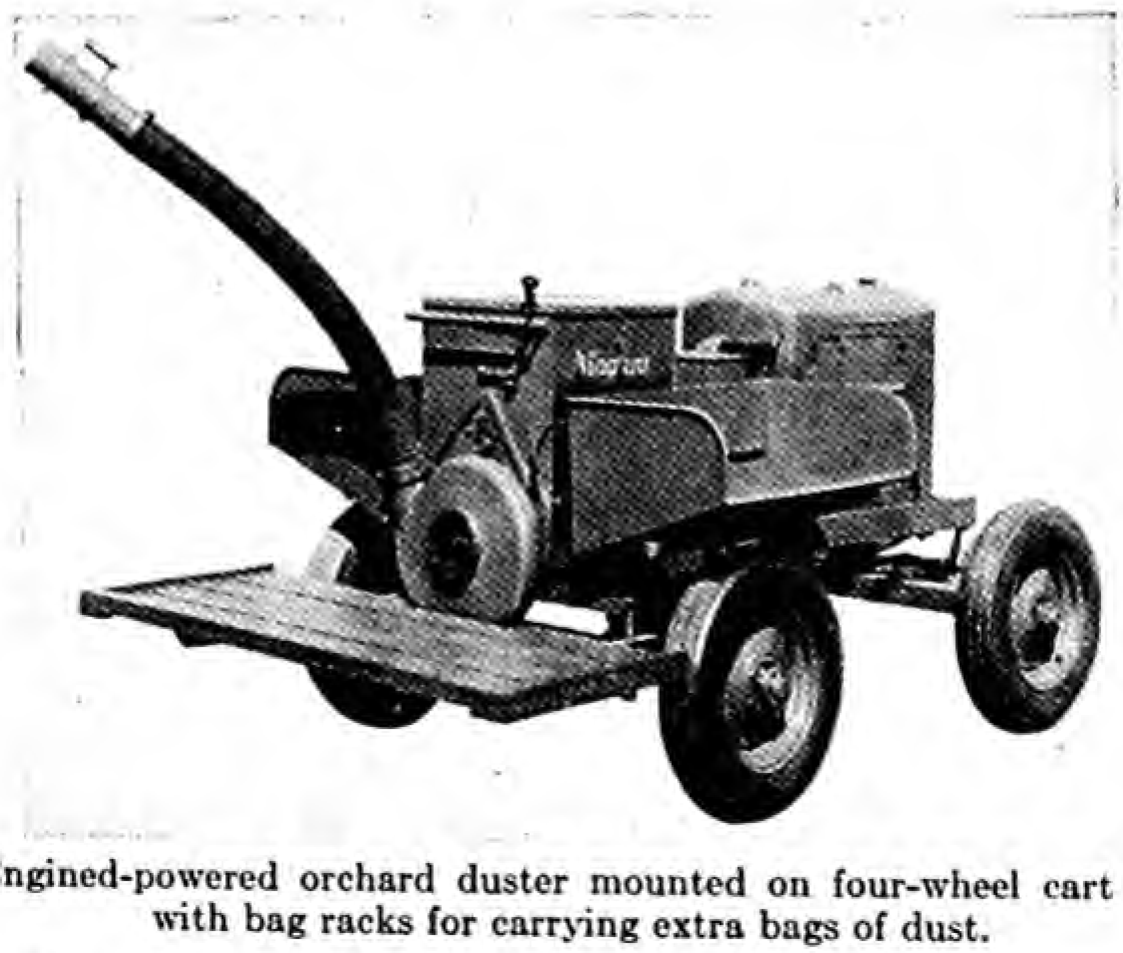


FIG. 401.—Engined-powered orchard duster mounted on four-wheel cart and equipped with bag racks for carrying extra bags of dust.

330. Orchard Power Dusters.—Figure 401 shows an orchard duster equipped with an auxiliary engine. Others may be mounted on the rear of a tractor or on a trailer and driven from the power-take-off (Fig. 402). Power units can be mounted on the floor of a truck, thus saving the cost

of a special sprayer chassis. Orchard dusters have only one large flexible metal hose, which can be turned to direct dust in any direction. Figure 403 shows a new development in orchard dusters.

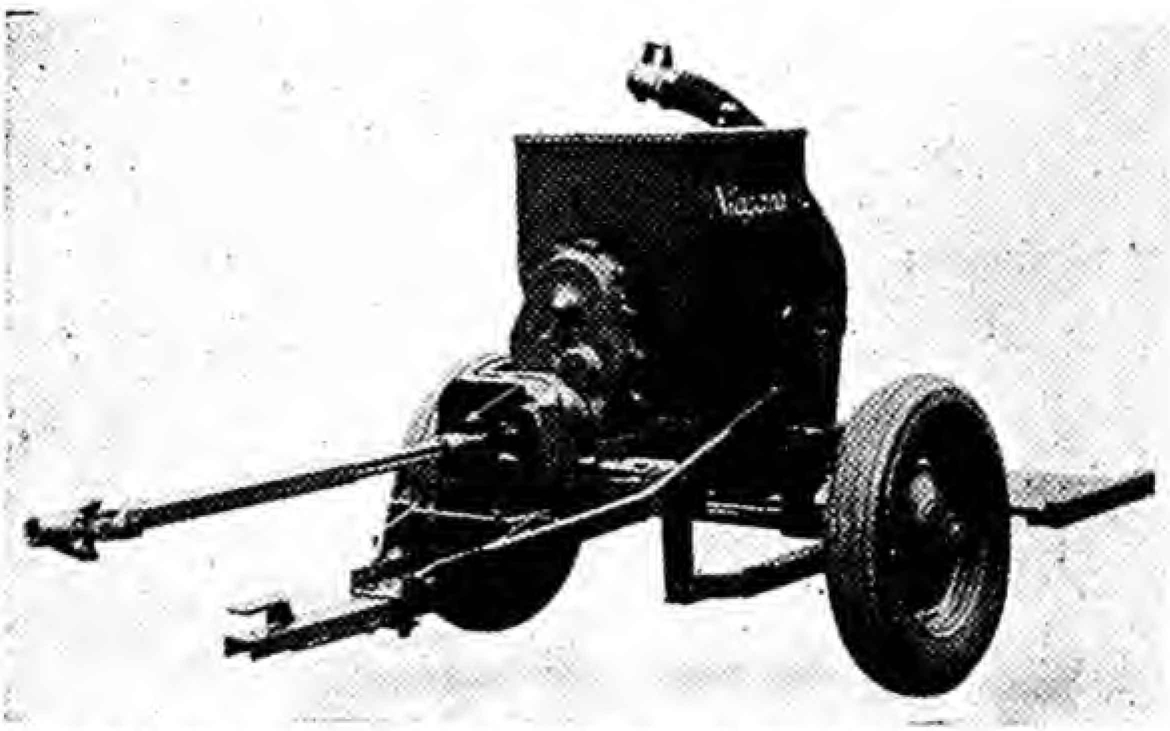


FIG. 402.—Two-wheel trailer-type single-discharge orchard duster with universal adjustable tractor hitch for attaching to popular makes of tractors.

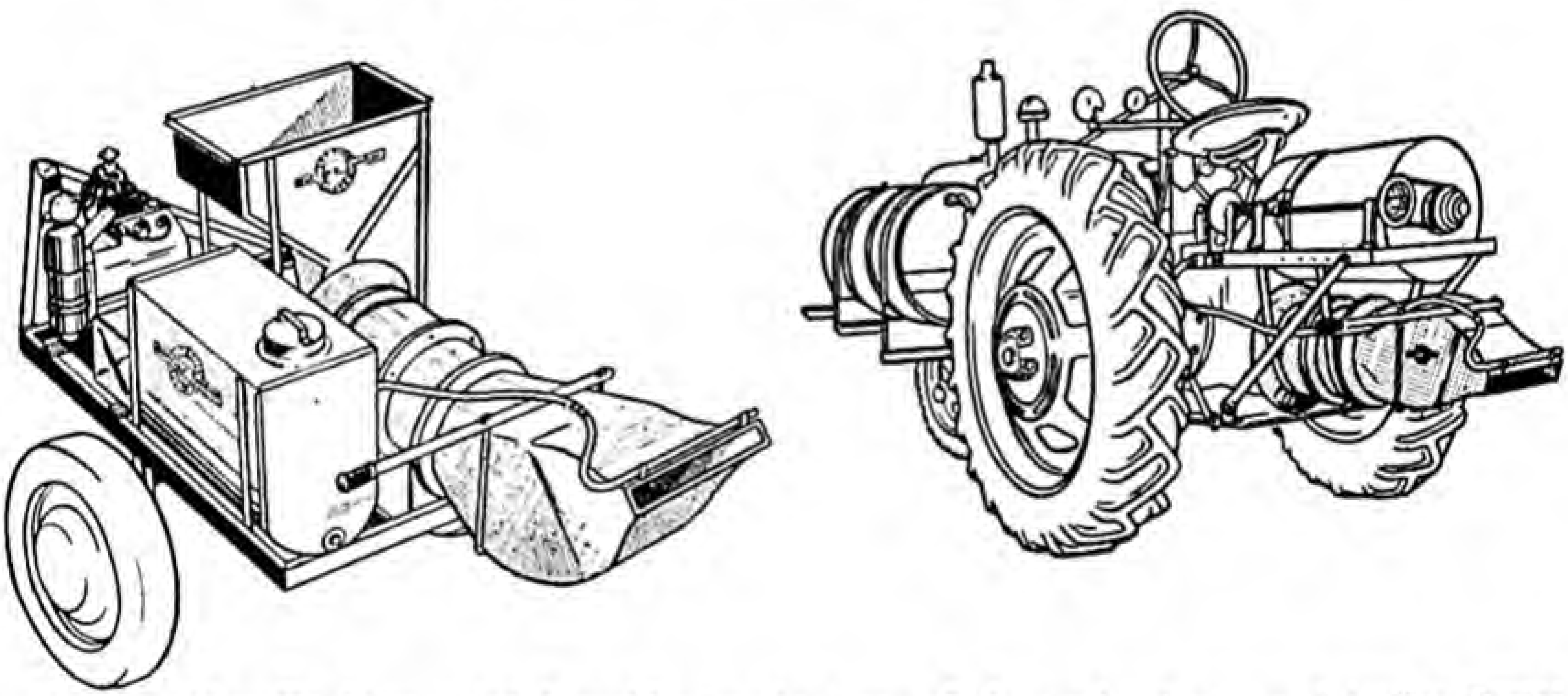


FIG. 403.—Turbine axial-flow blower dusters. *Left*, engined-powered trailer duster that can be pulled by truck or tractor. *Right*, tractor-mounted and power-take-off-driven model. An axial-flow-type fan furnishes a large volume of air at high pressure. This type of duster is suitable for orchards and large shade trees. It will also handle liquids.

331. Agitators.—Agitators are used to prevent dust preparations from caking and packing in the hopper. Most agitators consist of projections from horizontally mounted shafts, which revolve and keep the dust broken up.

332. Feeds.—Best results are obtained from dust "poisons" when they are broken up into a fine foglike dust. Small pelletlike particles do not adhere to the plants as well as a very fine dust. The feed usually consists of an opening into the air stream or fan housing. Revolving over the opening is a brush or curved blades, to which leather strips may or may not be attached. The dust is uniformly fed either directly into

the fan or into the air stream coming from the fan. The high velocity of the air aids in breaking the dust into a fine fog.

333. Fan.—The centrifugal type of fan is most often used on dusting machines. Fans usually have only one discharge opening, as shown in

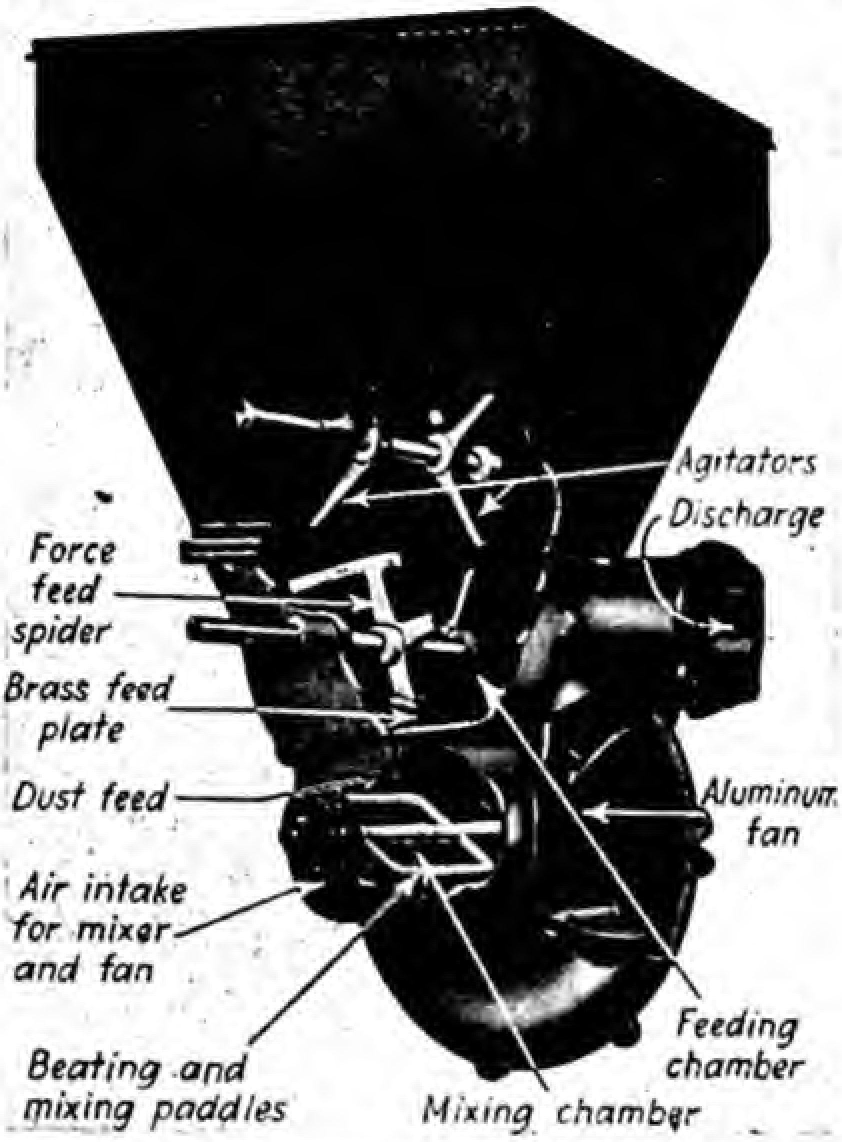


FIG. 404.—Sectional view of a duster showing hopper, agitators, feed, and fan.

Fig. 397. However, the fan shown in Fig. 399 has an opening for each hose. Fans operate from 2,500 to 5,000 r.p.m. One company claims their power machine will produce an air velocity of 125 m.p.h. at the fan outlet.

FIG. 405.—Dusting cotton by airplane.

334. Airplane Dusters.—Airplanes have been successfully used to apply dust to both field crops and orchards (Fig. 405). A V-shaped hopper capable of holding 500 pounds of calcium arsenate is built inside

the fuselage in the space ordinarily occupied by the front seat. The opening in the top for filling is covered by a close-fitting lid, hinged in front. The dust in the hopper is stirred just above the outlet at the bottom by an agitator driven by a small propeller mounted on the lower wing (Fig. 406*a*). The feed consists of an opening across the width of the fuselage. A slide covering the opening is operated by the pilot. The amount the feed valve is opened regulates the flow of dust and determines the poundage applied per acre. A venturi nozzle (Fig. 406*a*) is mounted underneath the fuselage and slightly in front of the dust outlet. The rear end of the nozzle is tipped slightly downward. The blast of air created by the plane's propeller rushes through the venturi nozzle at a high velocity, catching the dust and discharging it in a whirling cylindrical column that spreads and settles on the plants. It is claimed that the

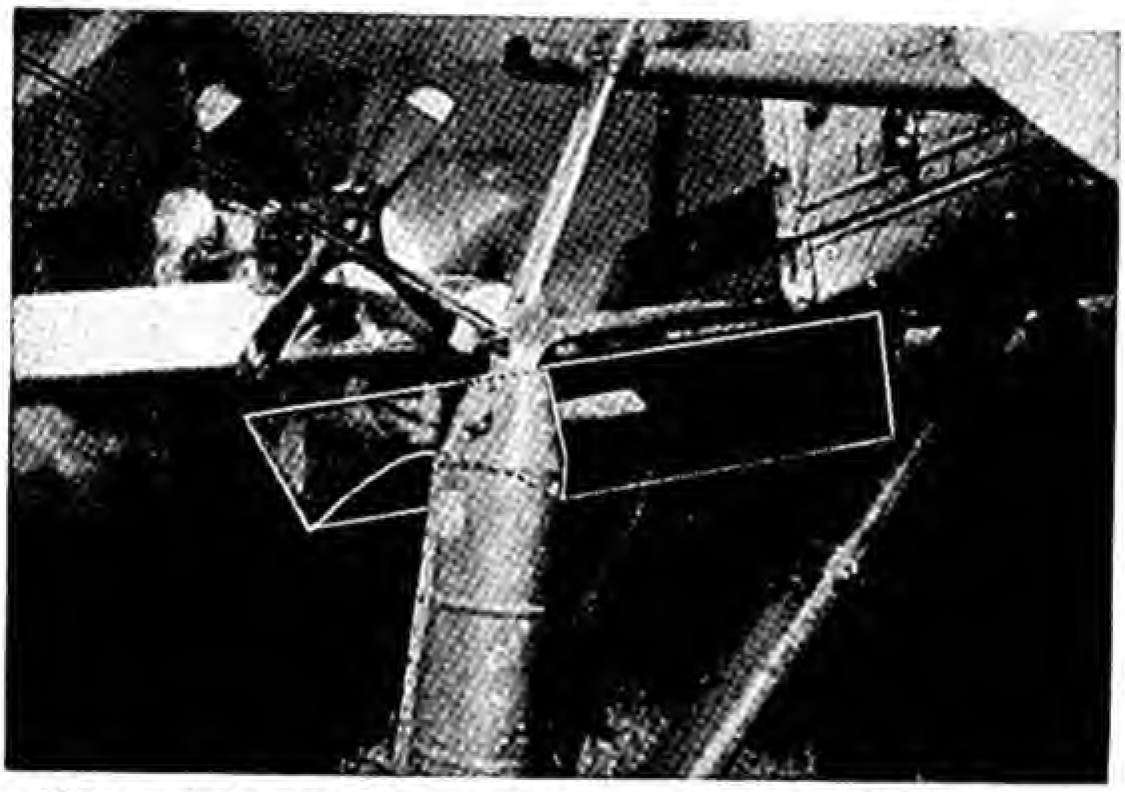


FIG. 406*a*.—Agitator drive and venturi nozzle of airplane duster.

high velocity of air through the nozzle creates a partial vacuum in the feed opening, which aids the flow of dust.

An airplane can dust approximately 350 or more acres per hour, which is many times the acreage that can be dusted with any other type of machine in the same length of time.[1] Data kept on the time required for airplane operations show the average loading time to be 3 minutes 5 seconds, average flying time per load 14 minutes 30 seconds, and the average dusting time per load 4 minutes 45 seconds. About one-third of the time is spent in actually dusting, the remainder being consumed in turning and flying to and from the landing field. The average contract price in 1936 for applying poisons to cotton was 4.5 cents per pound. The farmer furnished and paid for the poison.

335. Dust Mixer.—In the control of certain insects it is often necessary to mix two or more different kinds of chemical dust together. For

[1] *U. S. Dept. Agr. Farmers' Bull.* 1729, p. 14, 1934.

example, sulfur is often mixed with calcium arsenate. Figure 406*b* shows a stationary machine for the mixing of different kinds of chemical dust.

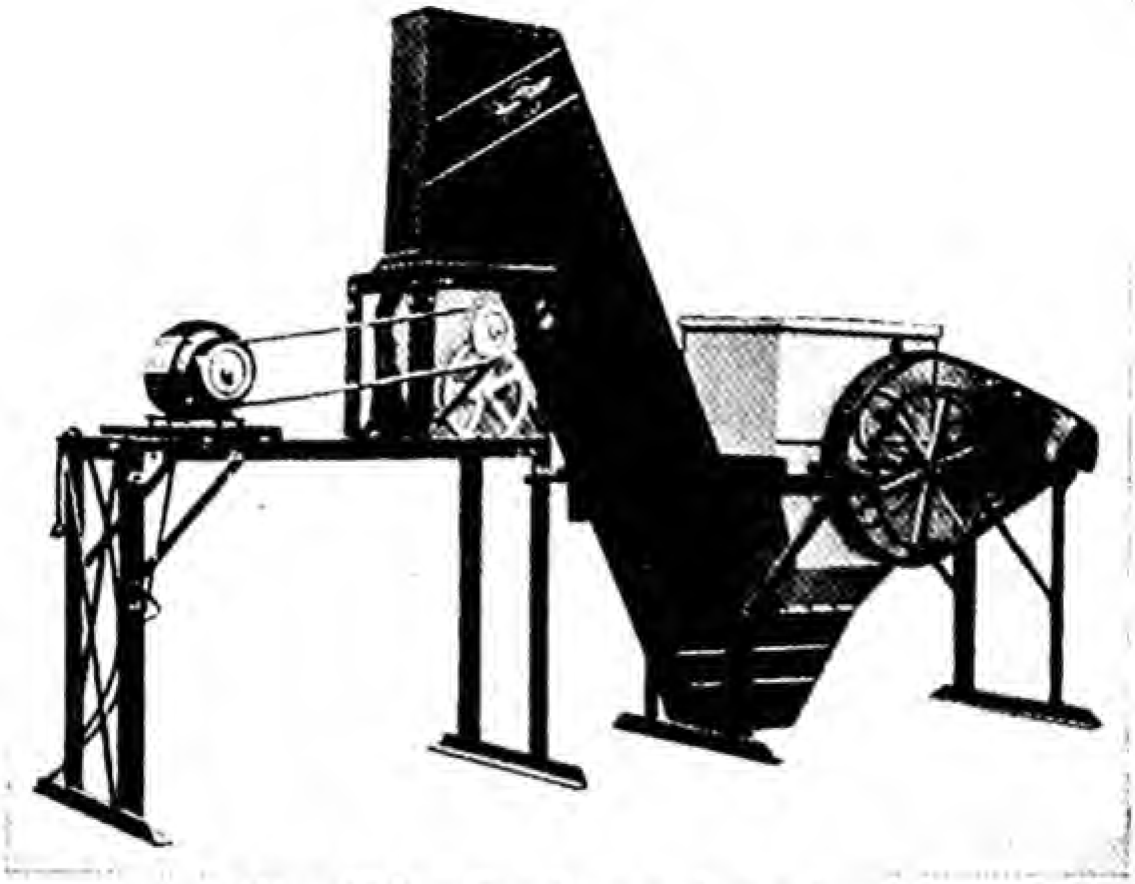


FIG. 406*b*.—Stationary dust mixer.

LIQUID SPRAYERS

Several liquid sprays are Bordeaux mixture, lime-sulfur solution, fish-oil soaps, oils, and oil emulsions. Machines for applying liquid sprays differ from dusting machines because the sprayer requires a pump instead of a fan to force the liquid out through the nozzle, which can be adjusted to regulate the quantity applied. Power sprayers require a pressure regulator to take care of the pressure created by the pump when all the nozzles are closed.

A *B*

FIG. 407.—*A*, continuous-action hand atomizer; *B*, continuous-action hand atomizer designed to spray oils, chemical solutions, and fly repellents.

336. Hand Sprayer or Atomizer.—The hand sprayer or atomizer is invaluable for spraying all kinds of solutions around the home, in the garden, poultry house, and barns. There are two types, namely, the

[1] *Tex. Agr. Expt. Sta. Bull.* 33, p. 32, 1929.

single-action and the continuous-action atomizer. The single-action type only acts on the stroke of the pump, but the continuous atomizer builds up enough pressure after two or three strokes of the pump to force out a continuous stream of spray (Fig. 407). The liquid containers are made of tin, glass, brass, and copper-bearing sheet steel. The last is adapted for spraying oils, chemicals of heavy consistency, floor oils, and fly repellents.

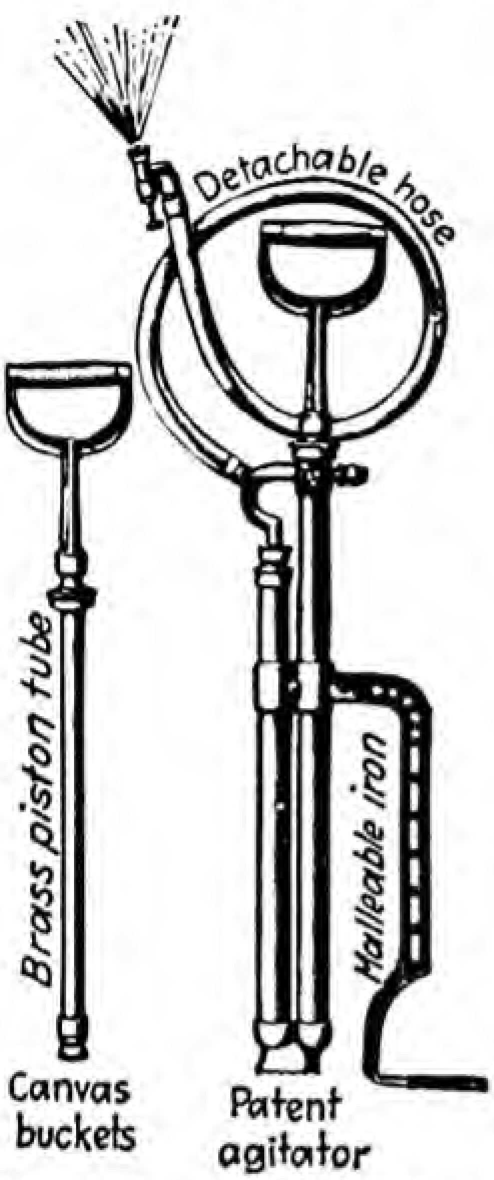


FIG. 408.—Double-acting bucket spray pump.

337. Bucket Sprayers.—The bucket sprayer (Fig. 408) is designed so that the pump sits inside a bucket, and a footrest sits on the ground outside. The footrest holds and steadies the pump, which pumps only on the down stroke. A strong continuous flow of liquid is forced through the nozzle under pressure of 50 to 100 pounds.

338. Barrel Sprayers.—This sprayer consists of a double-acting hand pump connected to a barrel or tank, which may or may not be mounted on a wheelbarrow-like frame. Some type of jet or dash agitator is provided to keep the spray solution stirred up. Strainers prevent small particles of sediment from getting into the hose line or nozzle (Fig. 409).

339. Knapsack Sprayers.—A 4-gallon capacity kidney-shaped tank made of galvanized steel or sheet brass is carried on the back and


FIG. 409.—Barrel sprayer.

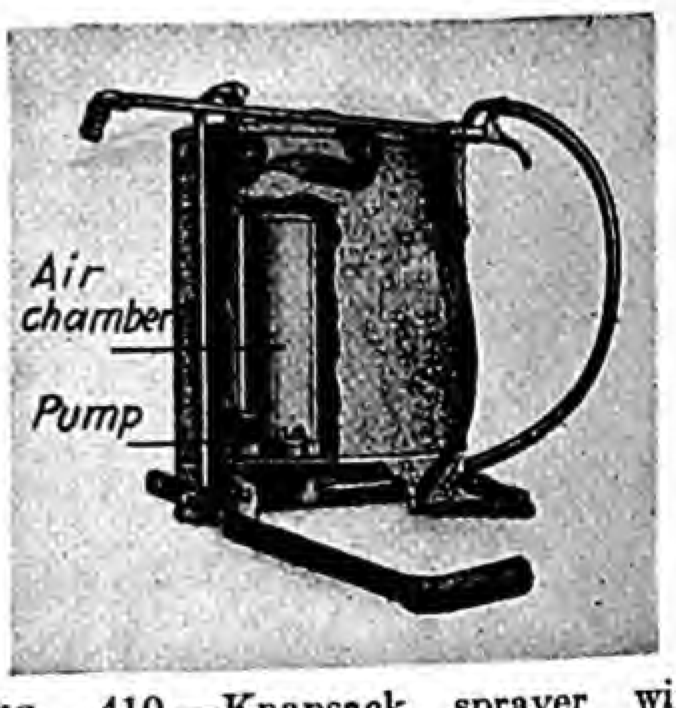


FIG. 410.—Knapsack sprayer with cutaway section to show pump and air chamber.

shoulders of the operator. A lever handle located at the bottom of the tank makes operation of the pump easy (Fig. 410). A few strokes of the pump build up pressure in the air chamber so that when the nozzle is opened a strong flow of liquid spray is assured. Knapsack tanks can be equipped with a double-acting, continuous-spraying, high-pressure, fire-fighting pump (Fig. 411) that will generate a pressure of 200 pounds and throw a stream of water 60 to 70 feet.

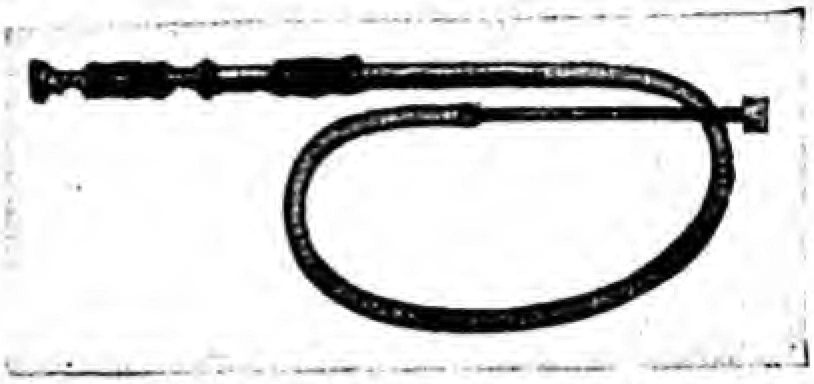


FIG. 411.—Trombone double-acting high-pressure spray pump.

340. Compressed-air Sprayers. This type of sprayer consists of a cylindrical tank equipped with an air pump (Fig. 412). The tank capacity ranges from 2½ to 4 gallons. When filled, the tank has enough space left so that a good volume of air can be compressed above the liquid and expanded sufficiently to force the spray out. The pump handle locks down and serves as a wrench for tightening and unscrewing the pump and for carrying the tank. Good spraying is obtained with 50 to 80 strokes of the pump. The author has used a high-pressure sprayer of this type made of heavy steel to stand a working air pressure of 120 pounds (Fig. 413). This sprayer was used to spray a highly atomized mist of arsenical poisons on prickly pear (cactus).

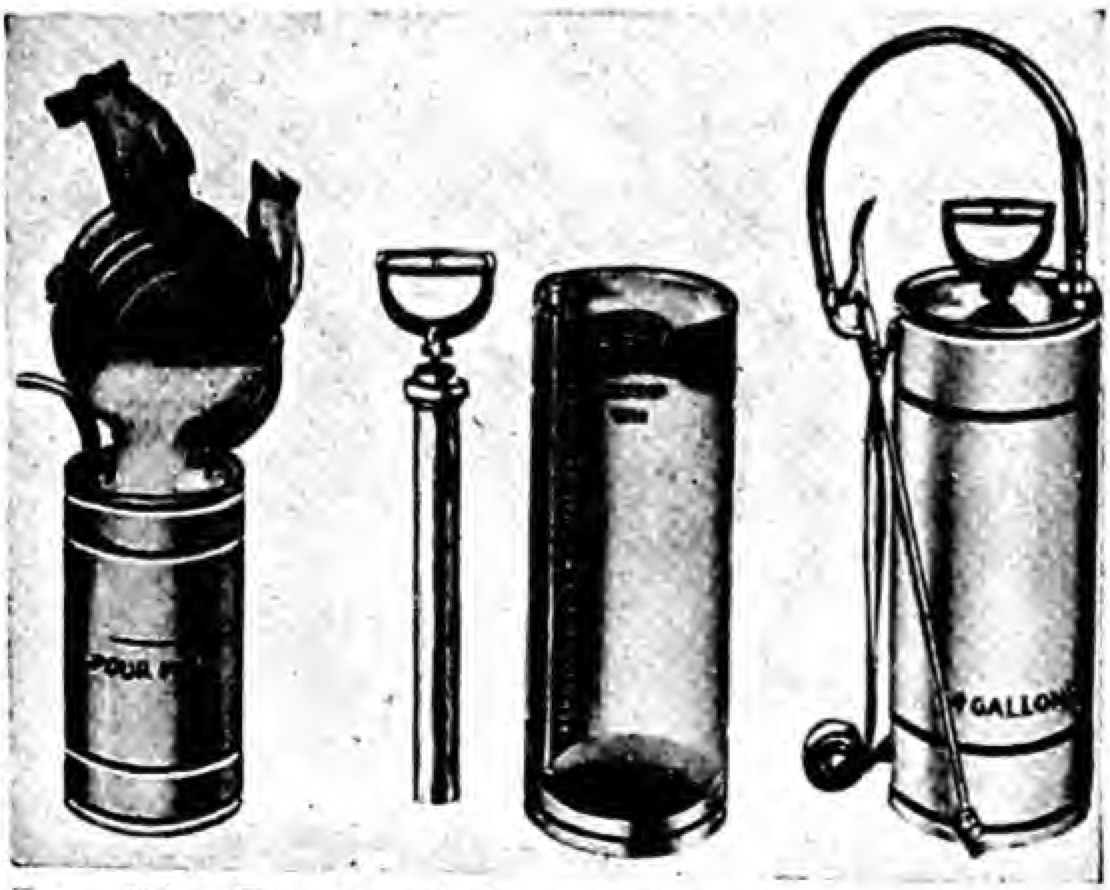


FIG. 412.—Compressed-air sprayer with depressed top, which serves as a funnel when filling the tank.

FIG. 413.—Australian prickly-pear atomizer.

341. Power Sprayers.—Power sprayers are shown in Figs. 414 and 415. They usually consist of a tank, pump, engine, pressure regulator, hose or pipes, and nozzles. Power sprayers are designed for spraying row crops, fruit trees (Fig. 414), and broadcast crops.

Fig. 414.—Orchard sprayer operated by power-take-off of tractor.

Tanks are constructed of wood or sheet metal that will not corrode. The capacity ranges from 100 to 400 gallons.

The pump usually has two or three plungers and is styled duplex or triplex. It must be constructed to stand in some instances pressures up to 650 pounds per square inch and must be capable of discharging from 5 to 40 gallons per minute.

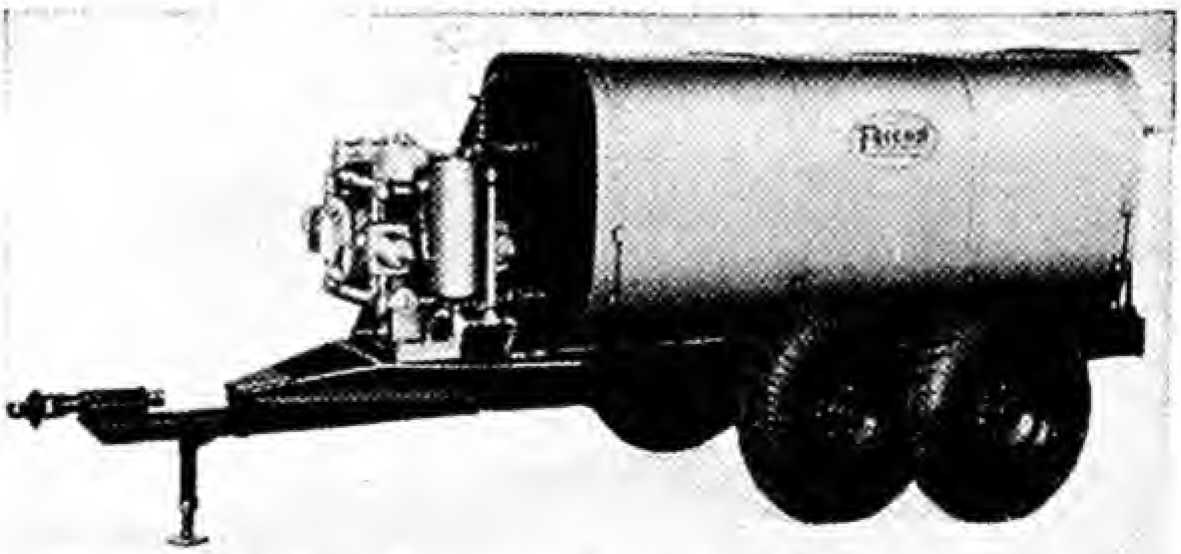


Fig. 415.—Trailer engine-powered sprayer mounted on "twin wheels" which make it easier to cross ditches and get over soft ground.

Pressure regulators are provided to take care of the pressure created by the pump when the nozzles are closed. A by-pass valve is automatically opened permitting the liquid to be returned direct to the tank until the nozzles are opened again (Fig. 416).

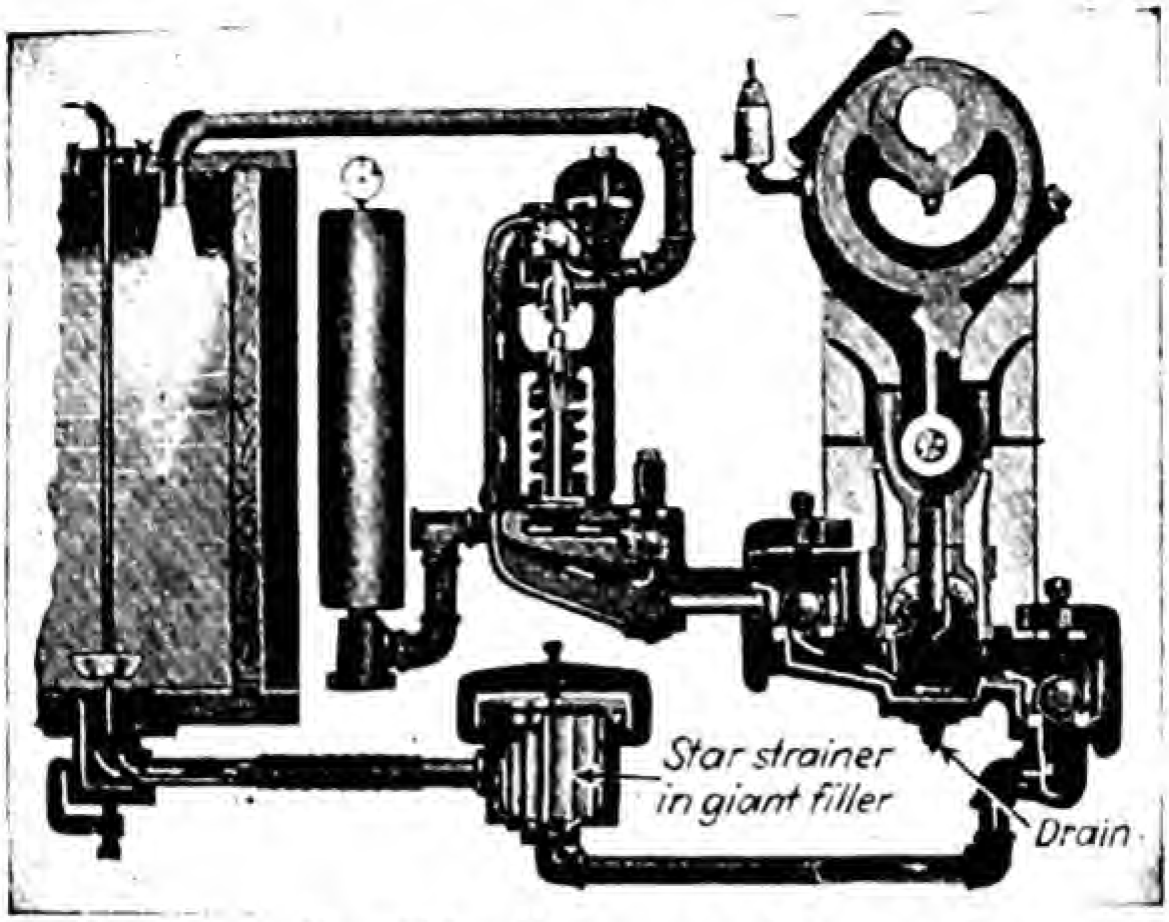


FIG. 416.—Pressure regulator.

342. Stationary Spray Plants.—A stationary spray plant is an outfit that remains in a fixed place. In general, the plant consists of a large-capacity tank, a power unit, and a pump of sufficient capacity to force spray liquids through underground pipes to all parts of the orchard. Lacy[1] enumerates fourteen advantages and only three disadvantages for stationary spray plants.

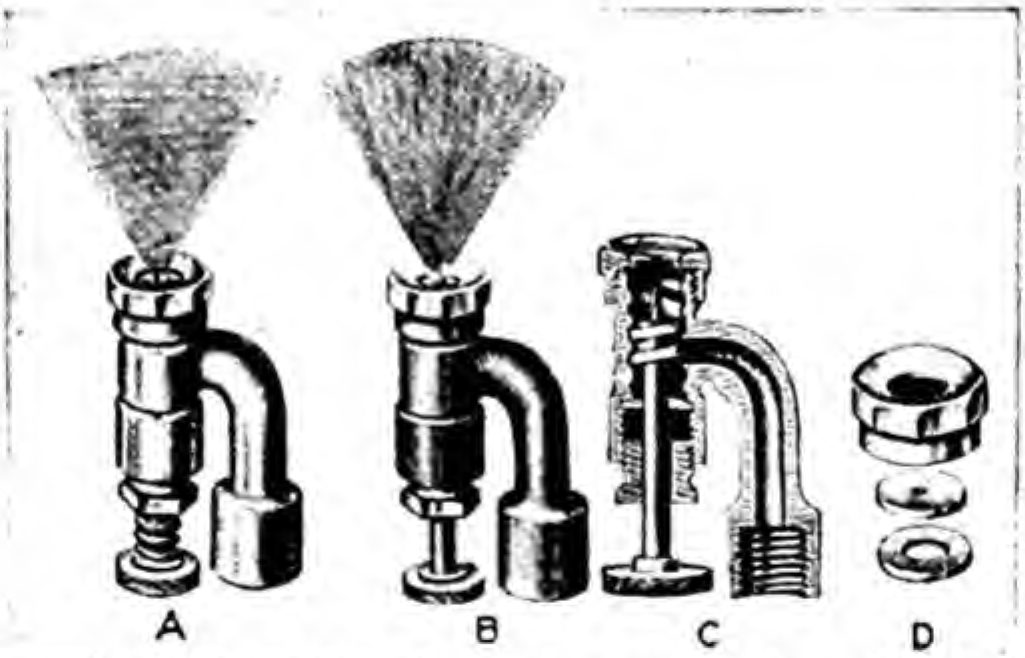


FIG. 417.—Vermorel spray nozzles: *A*, regular vermorel nozzle; *B*, graduate vermorel nozzle; *C*, sectional view of *B*; *D*, open cup, removal spray disc and packing ring for nozzle *B*.

343. Spray Nozzles and Guns.—When classed according to construction, there are five principal types of nozzles known as disc (Fig. 418), regular vermorel (Fig. 417), modified vermorel (Fig. 417), self-cleaner (Fig. 418), and Bordeaux (Fig. 418). Different nozzles are suited to different work, and the pressure used affects their efficiency. The disc

[1] *Agr. Eng.*, Vol. 13, No. 1, p. 19, 1932.

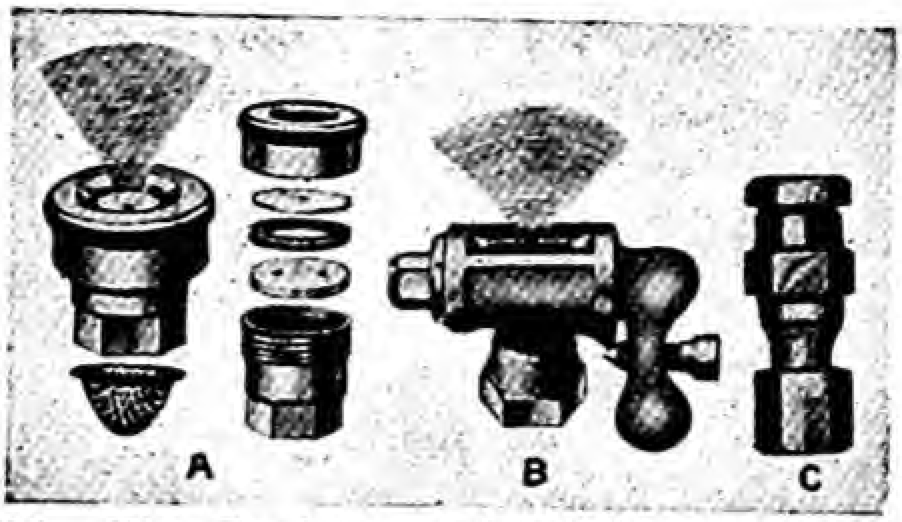


Fig. 418.—Disc, Bordeaux, and self-cleaner spray nozzles.

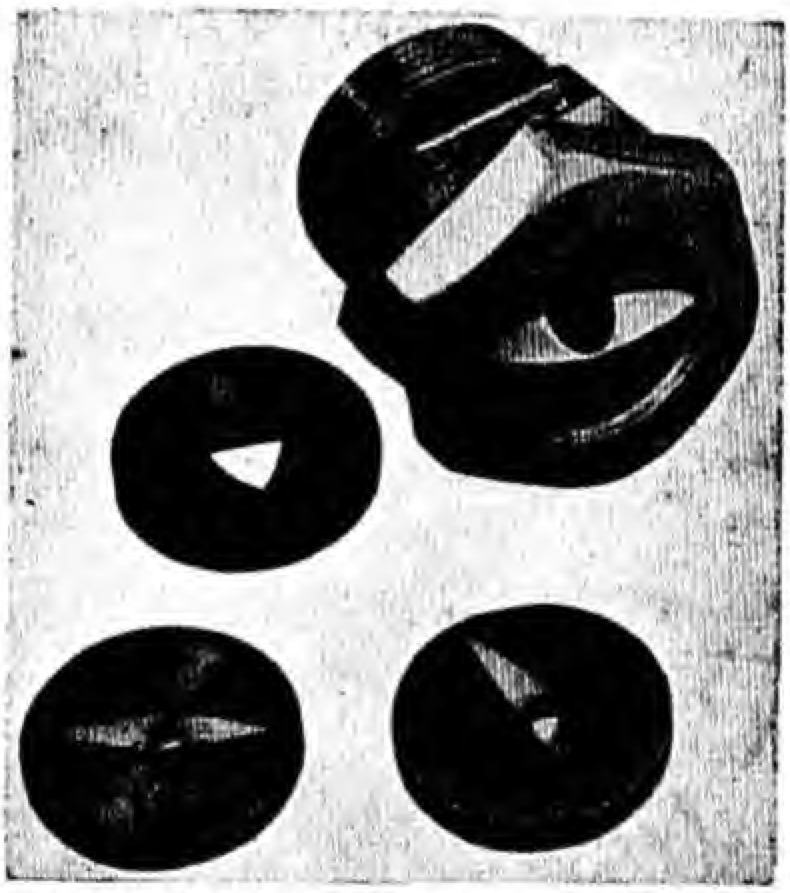


Fig. 419.—Nozzle for producing a flat spray.

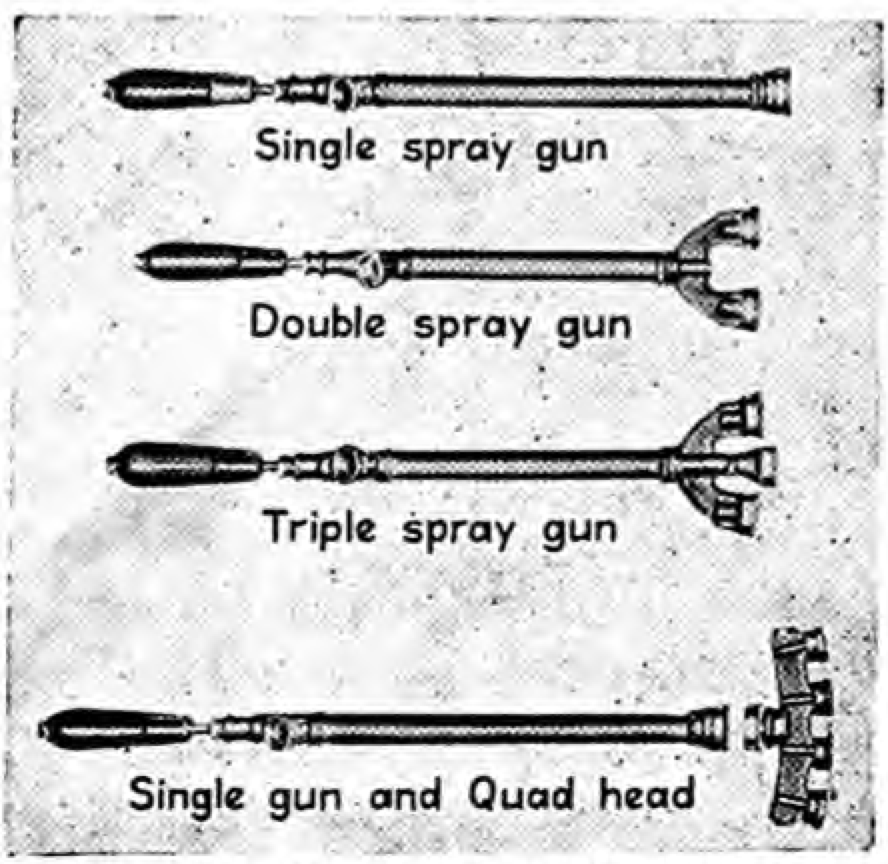


Fig. 420.—Various types of spray gun.

and Bordeaux nozzles have a larger capacity than the vermorel and self-cleaner types.[1] The type of spray, whether fine or coarse, can be regulated to some extent by the size, number, and angle of the holes in the disc. The Bordeaux nozzle usually makes a flat, fan-shaped spray, which may be rather coarse and much heavier in the center than at the edges. High pressure and small orifices help in making a highly atomized mist spray, a type that is coming into use. French and Crafts[2] recommend a hole in a concave-grooved disc to secure uniform flat fan-shaped spray for spraying weeds (Fig. 419). The disc is placed in the nozzle with the concave side out. Where several nozzles are used on a boom, the grooves are aligned so that the fan spray of every second nozzle meets. Figure 420 shows several types of spray gun used in spraying orchards.

[1] *Ohio Agr. Expt. Sta. Bull.* 248, p. 791, 1912.
[2] *Agr. Eng.*, Vol. 17, No. 3, p. 115, 1936.

PART VIII
HARVESTING MACHINERY

CHAPTER XX

HAY-HARVESTING MACHINERY

Hay-harvesting machinery consists of all the tools necessary in the handling of the hay from the time of cutting until it is placed in the barn or baled. Machines included are mowers, tedders, rakes, loaders, stackers, forks, carriers, and presses. These will be discussed in the order in which they are used in the process of making hay.

MOWERS

The mower is designed to cut grass for hay; however, it has various other uses. It is built in various sizes to suit almost any condition. The size is an influencing factor in determining the type, which may be one-horse, two-horse regular, or heavy and tractor mowers, the last named being mostly power-take-off types.

Horse-drawn Mowers

Most horse-drawn mowers are classed either as a *plain lift* or a *vertical lift*. The cutter bar of a plain-lift mower cannot be raised to a vertical position with the hand lever, while that of a vertical-lift mower can be. This type also has an automatic throw-out clutch.

344. Frame.—The frame (Fig. 421), which may be considered the foundation of the mower, is cast in one piece and made of cast iron. The heavy cast iron gives a rigid construction and will not allow the shafts and gears to get out of alignment.

345. Wheels.—All mower wheels are made of cast iron. The average height is 32 inches. The width of tire will vary from 3 to 4½ inches. Upon the face of the tire are lugs to aid traction with the ground for transmitting power to the cutting mechanism and to prevent slipping sidewise (Fig. 422). Wheels equipped with rubber tires can be obtained on special order (Fig. 423).

The ratchet and pawls are in the hubs of the wheels. The ratchet is placed on either the inner or the outer end of the hub. One method is about as common as the other. The pawls are fastened loosely or

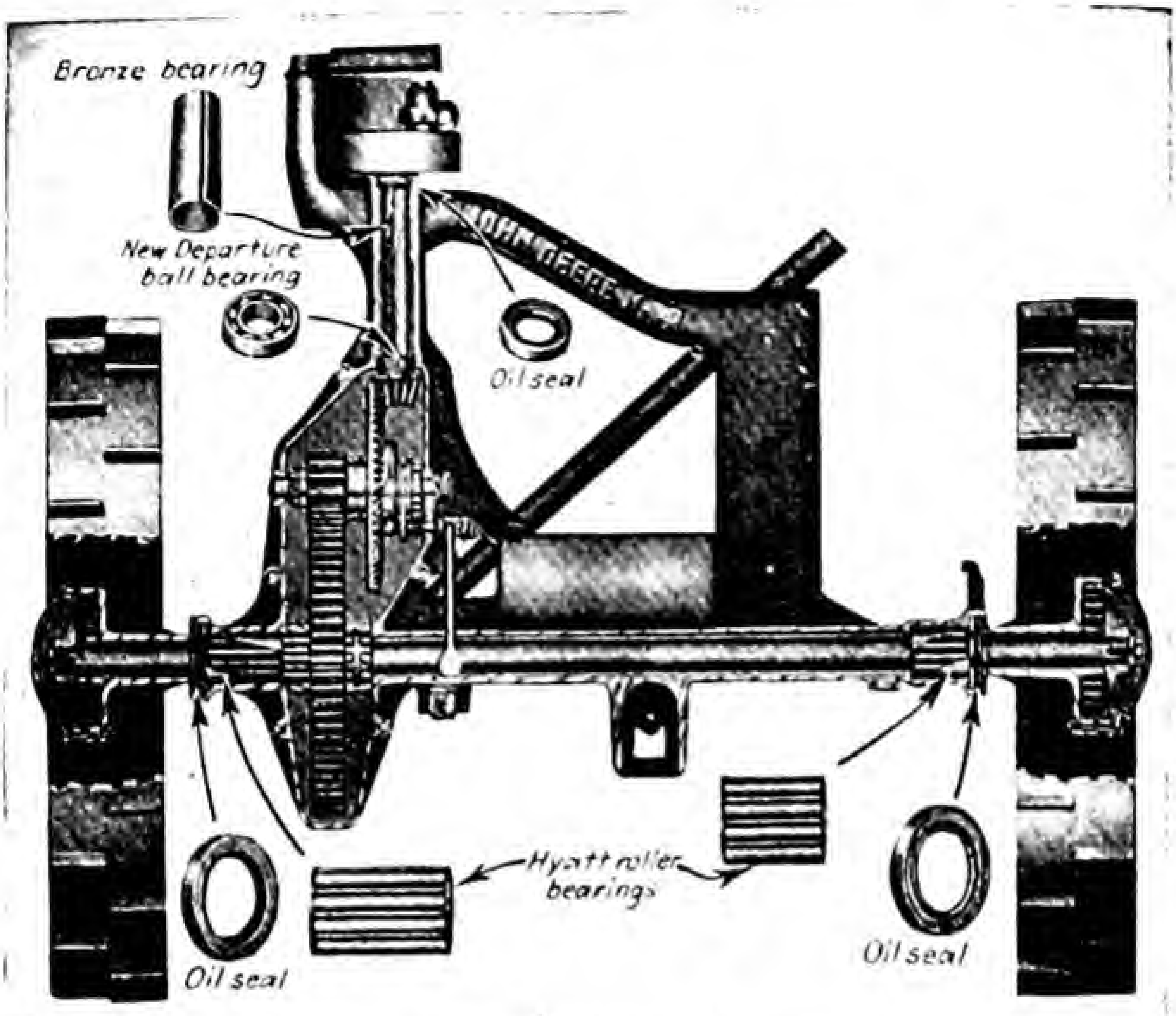


FIG. 421.—Mower frame showing enclosed gears and automatic lubrication of main operating parts. Note bearing and oil seals on axle line and pitman shaft.

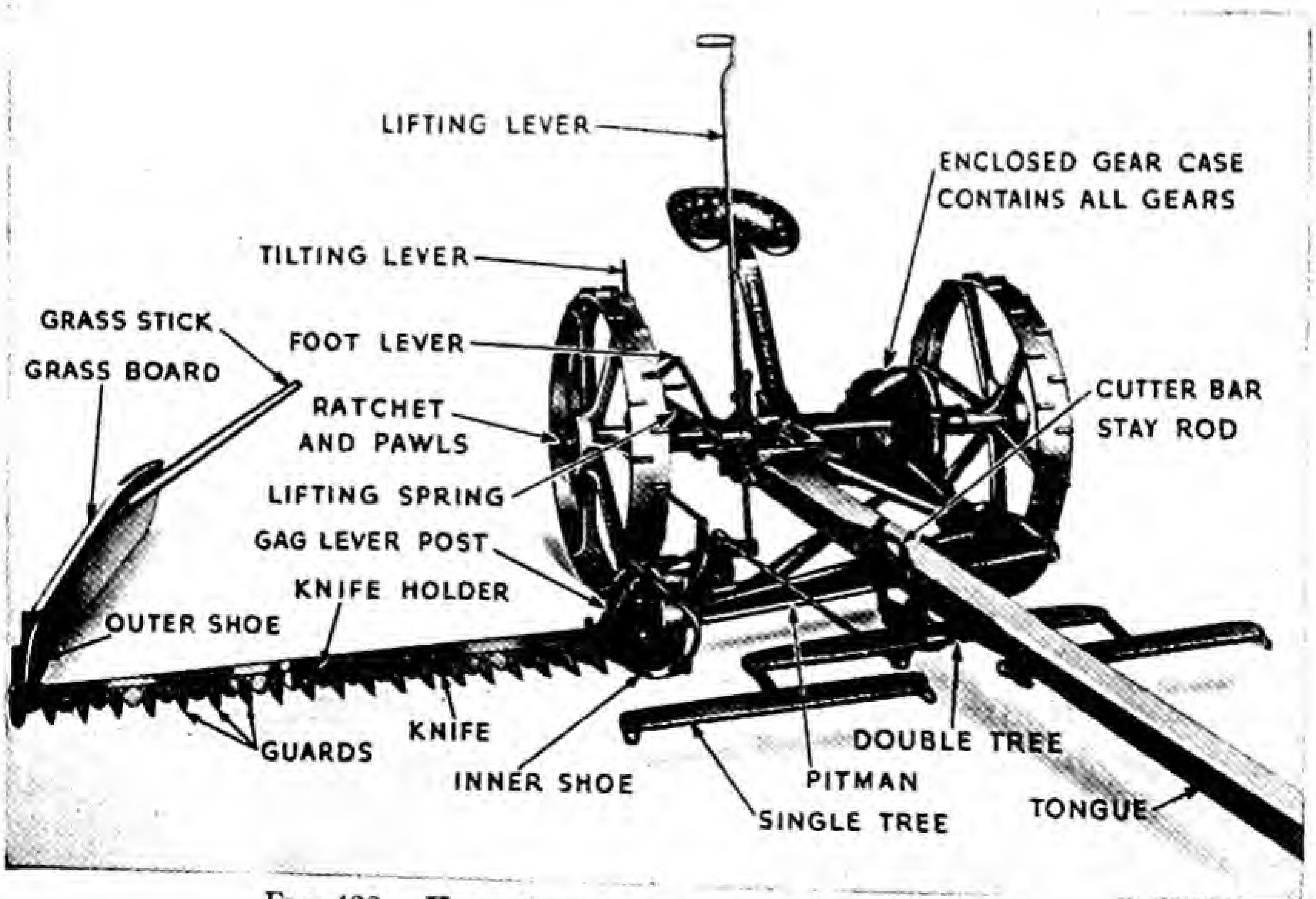


FIG. 422.—Horse-drawn mower with all parts named.

riveted to a pawl plate which is keyed rigidly to the axle. When the wheel is turned forward, the pawls engage the ratchet teeth and cause the axle to turn as a unit with the wheel. When the wheel is turned backward, the pawls slip over the ratchet, giving the clicking noise so noticeable in the operation of a mower. The ratchet and pawls transmit

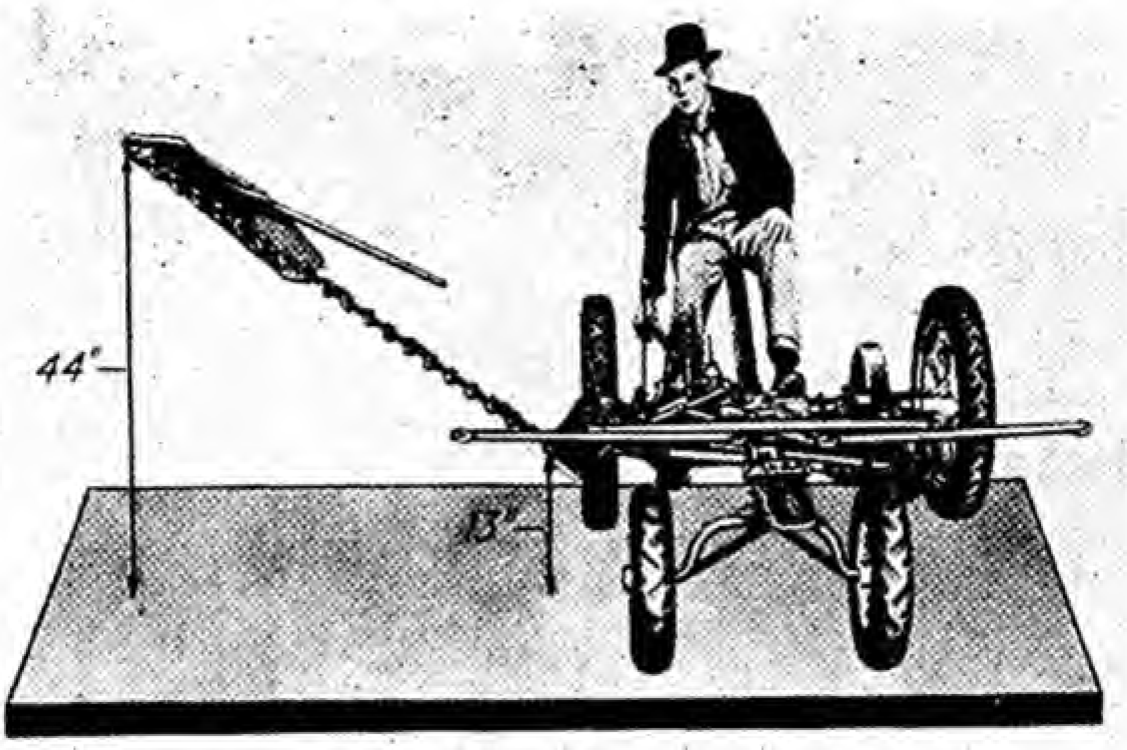


FIG. 423.—Horse-drawn mower equipped with tongue truck.

the power from the wheels to the main axle. There should be at least three pawls to each hub and no two of them should engage at the same time. They should be so arranged that they will engage immediately when the wheel starts turning. This prevents the mower from moving forward any distance before the knife starts.

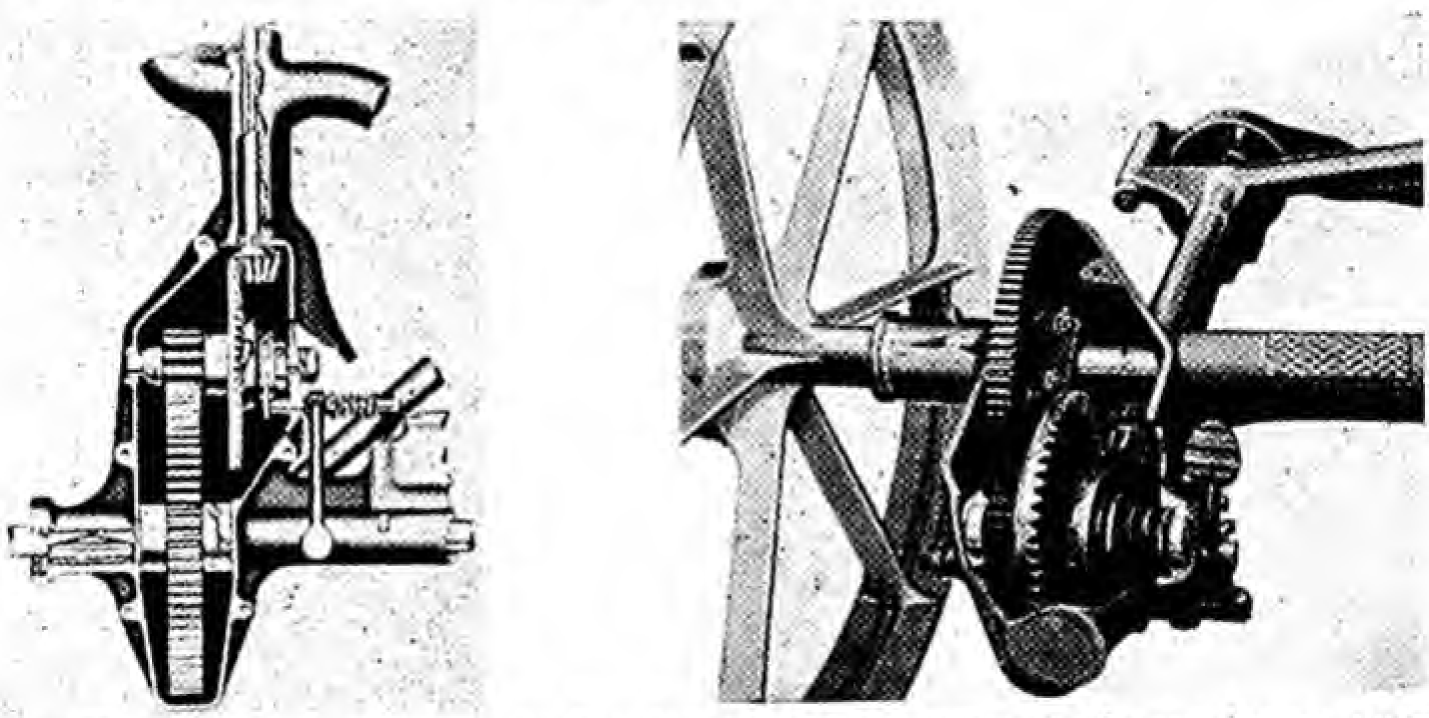


FIG. 424.—Two gear arrangements for transmitting power in horse-drawn mowers.

346. Gears.—In all horse-drawn mowers the power is transmitted from the axle to the cutting mechanism by means of gears (Fig. 424). The gears should be enclosed in a case partially filled with oil (Fig. 424).

347. The Clutch.—There are two methods of arranging the clutch on mowing machines so that the cutting mechanism can be thrown in and out of gear whenever desired.

One method is to place the clutch on the main axle and to the left of the center. The other arrangement is to place it on the countershaft, which is to the rear of the main axle. Figure 424 shows the clutch and gear assemblies for two mowers.

348. Crankshaft and Crank Wheel.—The power is transmitted through the spur gears to the bevel gears on the end of the crankshaft and is, in turn, transmitted through the crankshaft and crank wheel to the pitman. The crank wheel is much heavier on one side than on the other, or it is counterbalanced. The heavy part of the wheel is opposite that on which the wrist pin is fastened. As the crank wheel revolves, it gives a reciprocating motion to the pitman, and it is at this point that the rotary motion is changed into a reciprocating motion. The bearing in the lower end of the crankshaft and on the wrist pin must be examined frequently for wear. If there is any considerable amount of play, the bearing should be replaced. Whenever this is done the shaft and wrist pin should also be examined for wear.

349. Pitman.—Power is transmitted from the crank wheel to the knife by a pitman. It is usually made of wood, although it may be of steel (Fig. 425).

FIG. 425.—Pitman equipped with ball bearing.

350. Mower Sizes.—The size of the mower is determined by the length of the cutter bar or the width of the swath it will cut. If the mower will cut a swath 5 feet wide, it is called a 5-foot mower. This is the average size for two horses. However, the size may range from 4 to 7 feet. Some mowers are suitable for one horse, having a cutter bar only 3½ feet in length. Such mowers are good for small yards, lawns, parks, and orchards. Instead of having poles, as in the case of the two-horse type, thills are provided.

CUTTER BAR AND ITS PARTS

For the knife to do its work, it must have aid from a number of other parts which go to make up the cutting mechanism (Fig. 426). These consist of the cutter bar, inside shoe, outside shoe, guards, ledger plates, wearing plates, knife clips, grass board, and stick.

351. The Cutter Bar.—The cutter bar (Fig. 427) is made of high-grade steel. All other parts included in the cutting mechanism are connected directly or indirectly to it.

352. The Inside and the Outside Shoes.—A large shoelike runner (Fig. 427) supports the inner end of the cutter bar when in operation.

A removable sole is placed underneath the shoe and is adjustable to regulate the height of cut. The outside shoe (Fig. 427) supports the outer end of the cutter bar. It also has an adjustable sole to regulate the height of cut. The pointed front part of the outer shoe acts as a divider, separating the cut from the standing grass.

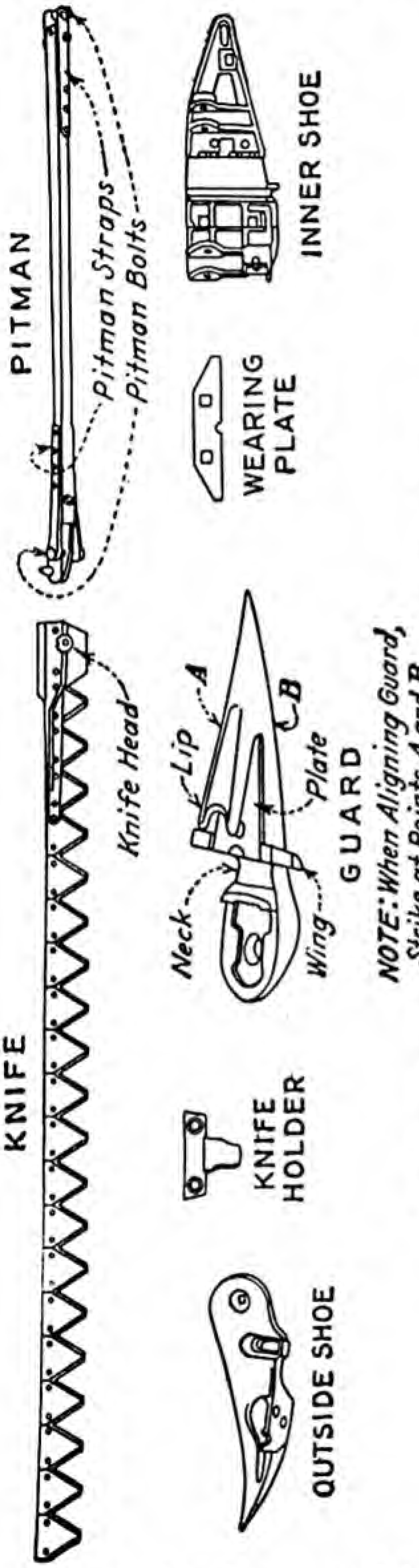


Fig. 426.—Various parts of a cutter bar with knife and pitman.

353. The Guards.—The guards serve to protect the cutting units (Fig. 426). They also provide a place for the ledger plates. They divide the material being cut so that the cutting units can do the best work. If any of the guards get out of alignment, they should be hammered back in place. Special grain or pea- or bean-vine lifters are often used to facilitate the cutting of fallen material.

354. Ledger Plates.—The ledger plates are riveted to the guard (Fig. 428). They form one half of the cutting unit, the knife sections acting as the other half. The edges of the ledger plates are serrated to prevent stems of grass from slipping off the point of the shears. When a ledger plate becomes worn and dull, it should be replaced with a new one. Figure 429 shows a special anvil for removing and replacing ledger plates and knife sections.

355. Wearing Plates.—Wearing plates (Fig. 426) are necessary to support the rear side of the knife. When they become worn, the rear side of the knife will drop down, causing the sections to kick up and not make close contact with the ledger plates. Heavy draft and poor cutting will result from such a condition. The wearing plate under the knife head should not be overlooked when repairing a mower.

356. Knife Clips.—Knife clips or holders (Fig. 427) are essential to hold the knife sections down close against the ledger plates. If they

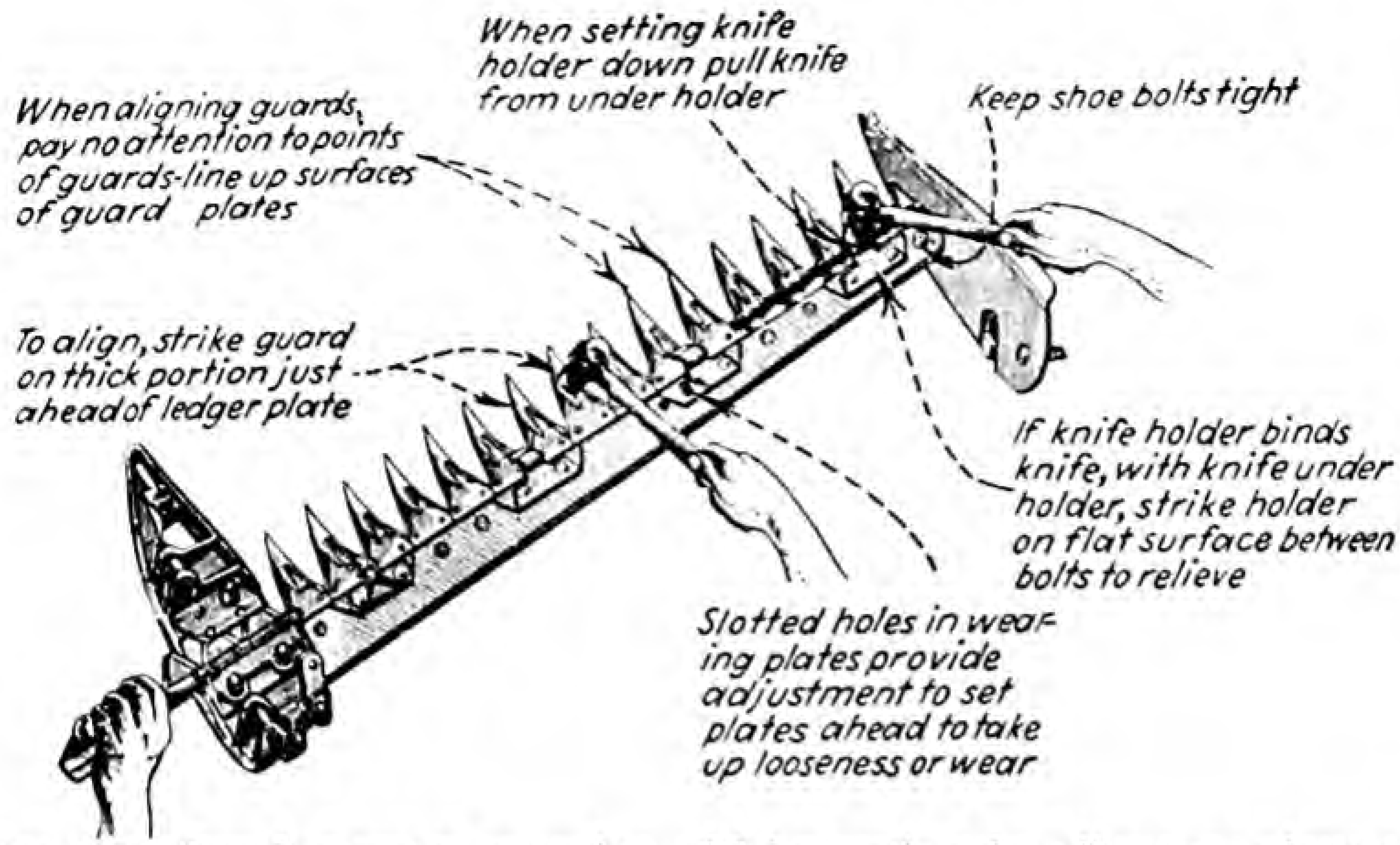


FIG. 427.—Complete mower cutter bar, with instructions for adjustment of parts.

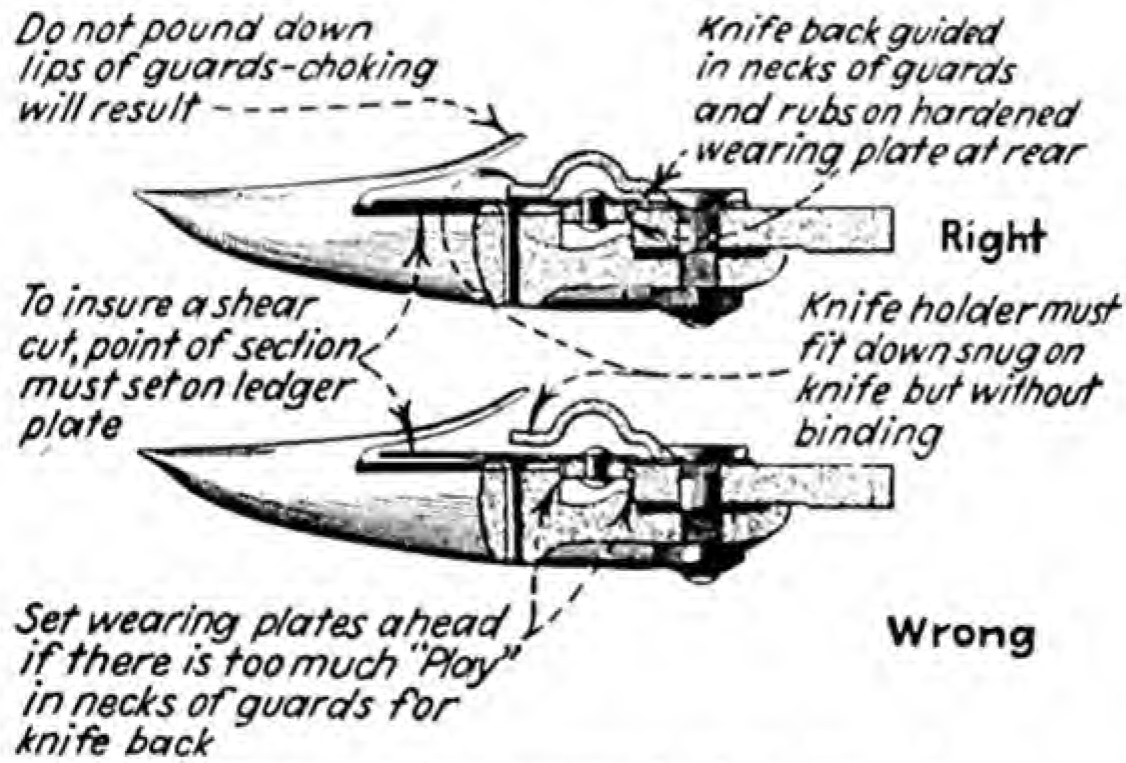


FIG. 428.—Right and wrong way for a mower knife to fit and operate in the guards.

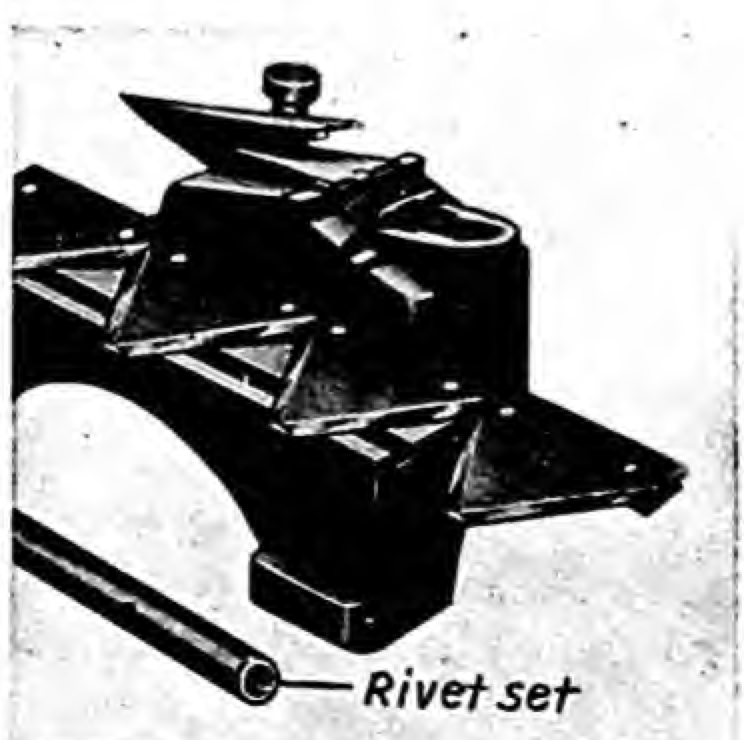


FIG. 429.—Special anvil for removing and replacing ledger plates and knife sections.

become worn and allow the knife to play up and down, making poor contact with the ledger plates, they should be hammered down. They are made of either malleable iron or steel.

357. Grass Board and Stick.—These parts are attached to the outer shoe. The board with a yielding spring connection angles back away from the uncut grass. Its purpose is to divide and rake away the cut from the uncut grass, to give a clean place for the inside shoe on the next round. For long and tangled material a *rotary* grass board can be secured that will leave a cleaner swath than the regular type.

FIG. 430.—Never remove the sections from a mower sickle *with the sections up*.

358. Alignment of Cutter Bar.—To do the best work with a mowing machine, it is essential that the center of the pitman box, the knife head, and the outer end of the knife bar be in a straight line *when operating*.

When not in operation, however, the outer end of the bar, when in cutting position, should be a little in advance of the inner end to offset the backward strain produced by the pressure of the cutting and to permit

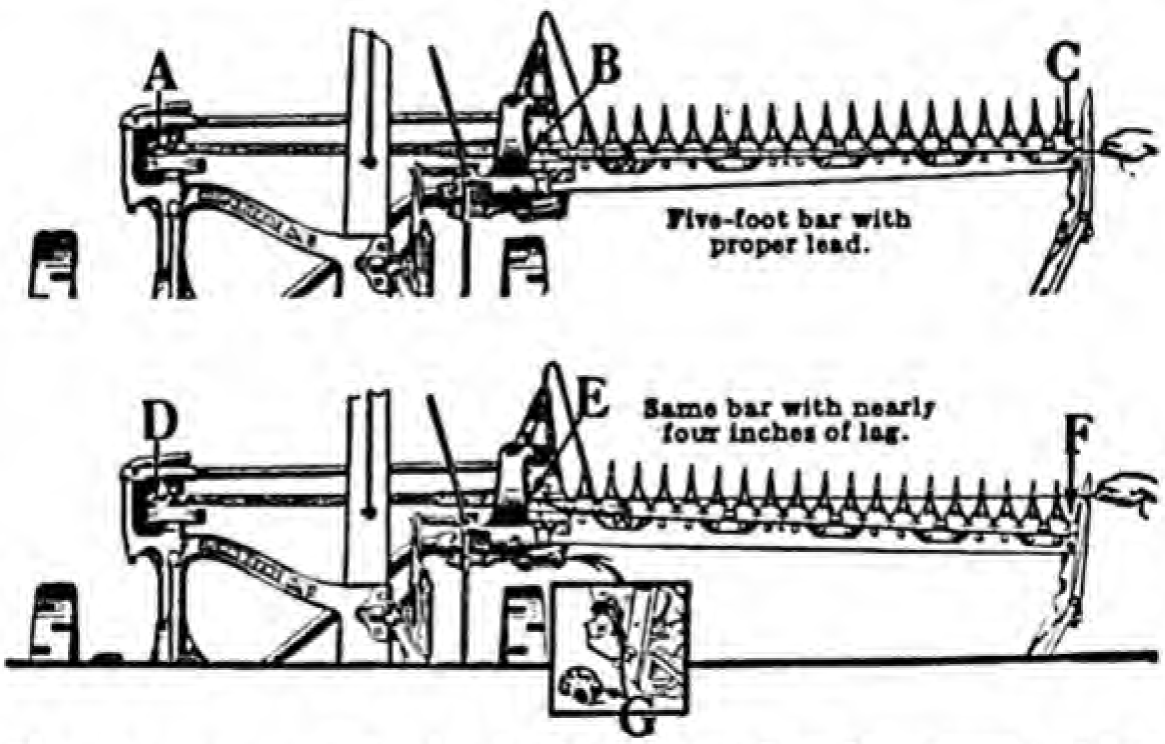


FIG. 431.—How to measure the lead of a cutter bar for proper alignment. Point *C* should be from 1 to $1\frac{1}{4}$ inches ahead of points *A* and *B*. Points *D*, *E*, and *F* show a cutter bar with too much lag at *F*.

the knife and pitman to run in a straight line. This setting is called *lead.* The outer end of the bar should be ahead of the inner end 1 to $1\frac{1}{4}$ inches on $4\frac{1}{2}$-foot mowers; $1\frac{1}{4}$ to $1\frac{1}{2}$ inches on 5-foot mowers; and $1\frac{1}{2}$ to $1\frac{3}{4}$ inches on the 6- and 7-foot sizes.

Figure 431 shows a method of measuring to determine the proper lead for the cutter bar.

The inset in Fig. 431 shows how an eccentric bushing can be used to adjust the lead for a cutter bar.

359. Registration.—This means that each section of the knife should center with the center of each guard, when the knife is at the extreme end of its in-and-out strokes (Fig. 427) Failure to register is a very common trouble in mowers and should be looked for often. The results of failing to register are an uneven job of cutting, an uneven load on the entire mower, heavier draft, and, often, clogging of the knife. When an attempt is made to align the cutter bar by lengthening or shortening the drag bar, it may, at the same time, disturb the registration of the knife sections with the guards. To adjust registration, the whole cutter bar, including the inside and outside shoes, is moved in or out.

Special Attachments

The mowing machine is often required to cut under difficult conditions and to perform special work. Attachments to facilitate doing such jobs are mentioned briefly.

360. The Bunching Attachment.—This attachment consists of a number of fingerlike bars extending to the rear of the cutter bar and

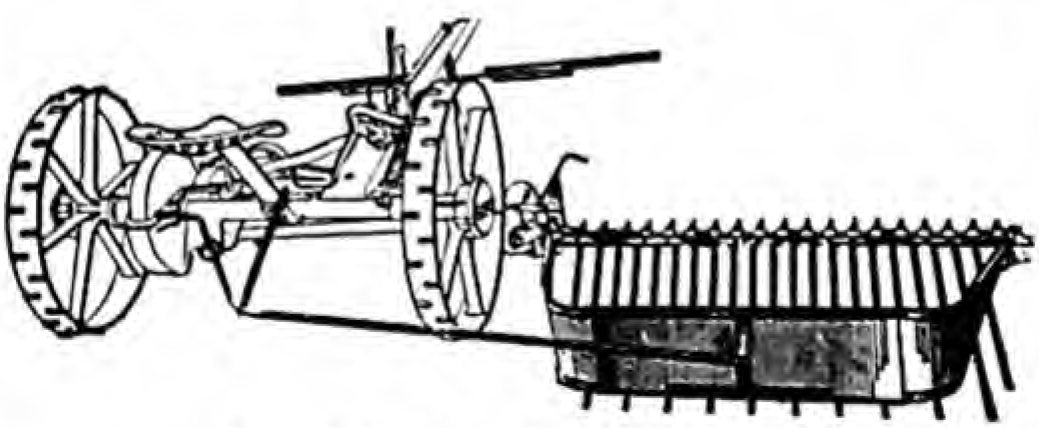


Fig. 432.—Bunching attachment.

having a special hoodlike arrangement that attaches at each side and around the rear ends of the fingers (Fig. 432). This hood is allowed to remain down until quite a bunch of hay has been collected, when it is lifted by a foot lever, allowing the bunch of hay to slide off the bars.

361. The Reaping Attachment.—This attachment is used mainly for cutting clover for seed. It has an extra seat placed over the right wheel so that the operator can be closer to the cutter bar in order that he may use a rake to rake the clover off in bunches from a small wooden platform made out of wooden slats (Fig. 433).

362. Grain, Pea, and Bean Lifters.—These lifters consist of guards attached over the regular guards, which project to the front quite a

distance so that pea and bean vines can be lifted, allowing the cutter bar to slide underneath and cut off the stems below the heads (Fig. 434*a*).

363. Weed Attachment.—This attachment consists of a wheel placed at the outer end of the cutter bar to carry it some 6 to 12 inches off the ground, so that the weeds may be cut without undue strain upon the mower parts.

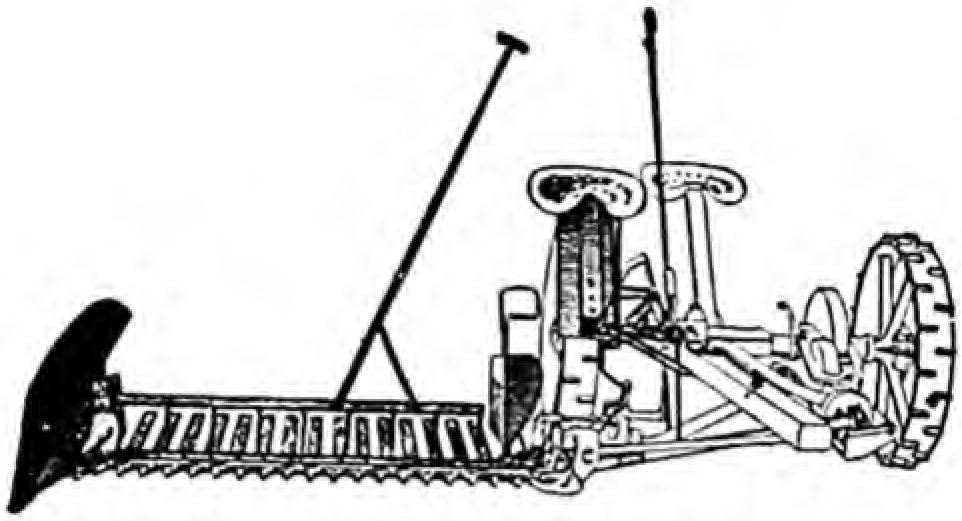


FIG. 433.—Reaping attachment for mower.

364. Weed and Brush Bars.—These bars are constructed with stub guards instead of the long sharp-pointed guards used for cutting grass. Extra-heavy knives are also used with them.

365. Windrowing Attachment.—The windrowing attachment consists of a number of bars attached to the cutter bar, curved upward at the rear end. The bars are about 3 feet in length at the outer end and gradually increase in length toward the inner end where they are some

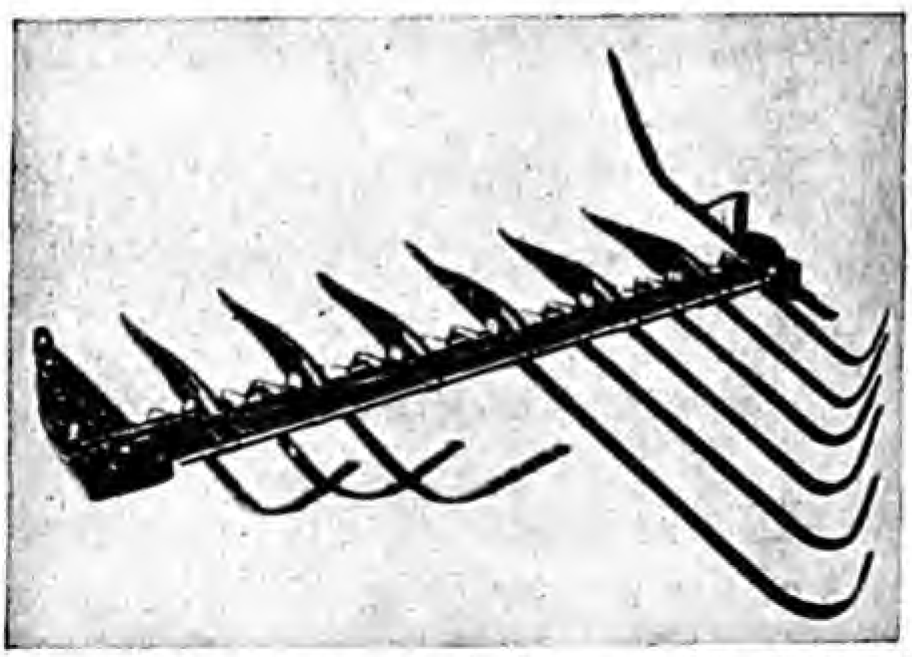


FIG. 434*a*.—Pickup guards and center windrow used in harvesting canning peas.

8 feet long (Fig. 434*b*). The hay is allowed to slide to the side into a windrow. Some of these attachments can be folded to allow bunching. The windrow attachment is especially adapted for harvesting flax, clover, alfalfa, peas, and other crops.

366. Bermuda-grass Cutter Bar.—Another special type of cutter bar being made has twice as many guards as the regular type. These guards are narrow, with ledger plates on each guard, and are so placed

that the knife, in making an in or an out stroke, passes through two guards instead of one. It is claimed that this arrangement is effective in cutting Bermuda grass, which becomes very closely matted together.

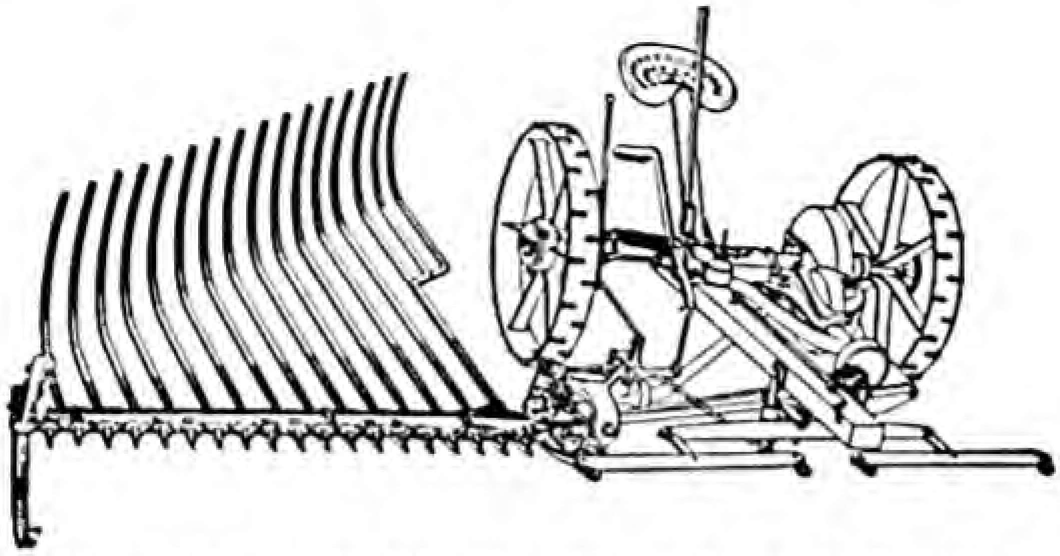


Fig. 434b.—Side-delivery windrowing attachment.

367. Lespedeza Bar.—Figure 435 shows a cutter bar equipped with special narrow guards, a seed screen, and a pan to receive the seed.

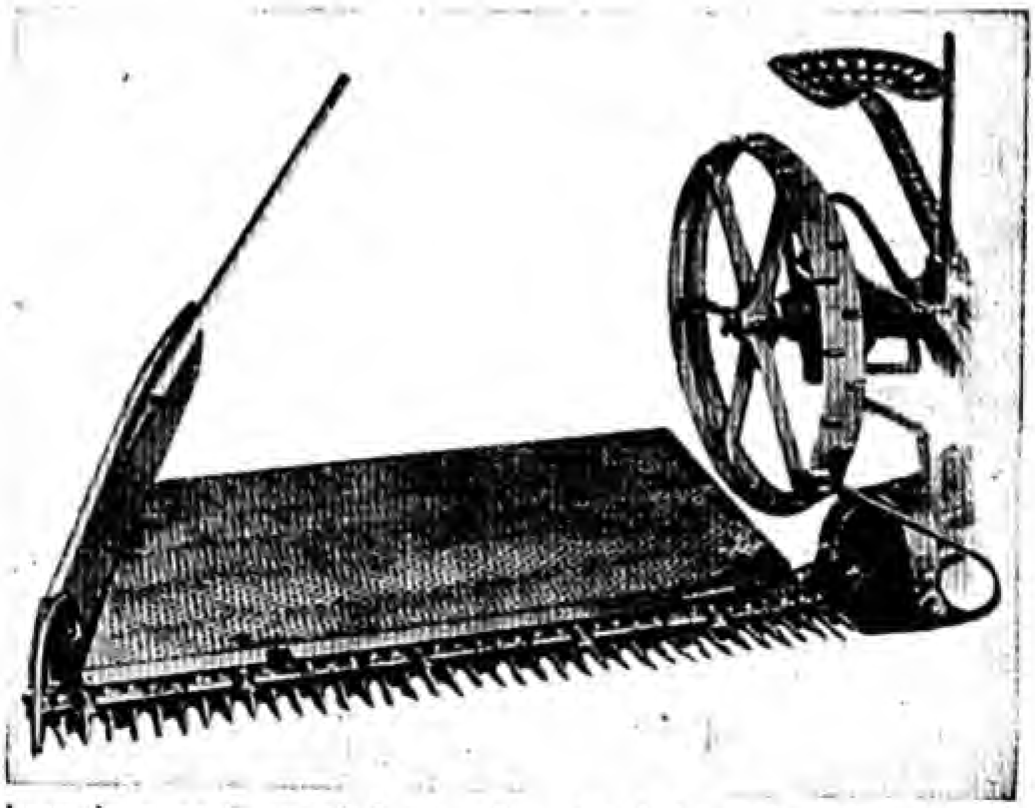


Fig. 435.—Lespedeza bar and special pan for receiving the seed that are shelled in the process of cutting.

368. Tongue Truck.—Tongue trucks on a mower take the weight of the tongue off the team, prevent whipping of the tongue on rough ground, and reduce side draft.

Mower Troubles

369. Draft.—Excessive draft on a mower may be caused by

1. Dull knives.
2. Worn ledger plates.
3. Poor lubrication.
4. Nonalignment of cutter bar.
5. Nonregistration.

Duffee, of the University of Wisconsin, found in his experiments on the draft of mowers under field conditions that the condition of the cutting parts was the most important factor. Table XIII shows the effect of dull and sharp knives and dull and sharp ledger plates.

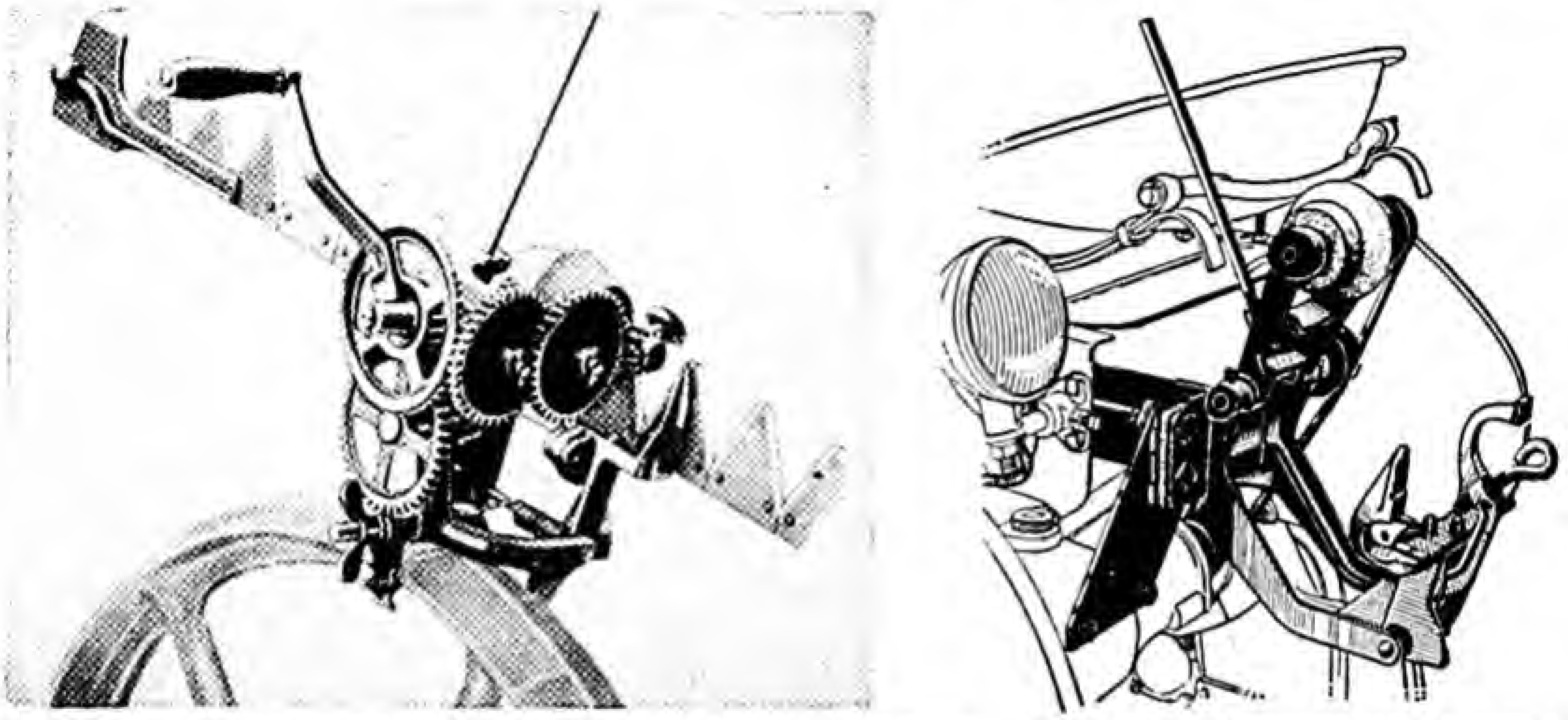


FIG. 436.—Knife grinders for horse and tractor mowers. *Left*, grinder attached to mower wheel. *Right*, grinder attached to tractor and power-driven.

A study of the table shows that when the knives were dull and the ledger plates in poor adjustment, draft was increased 30 to 35 per cent. Very little was gained by sharpening the knife and leaving the ledger

TABLE XIII.—RESULTS OF DRAFT TESTS ON A 5-FOOT MOWER TO DETERMINE THE EFFECT OF SHARP AND DULL KNIVES AND SHARP AND DULL GUARDS[1]

Condition of cutter bar	Total draft, pounds	Increased draft, pounds	Per cent increase	Speed in miles per hour	Horse-power required to pull mower
Bar in first-class condition, new and sharp	297	...	....	2.5	1.98
Bar in very poor condition, guards dull, wearing plates worn, knife fairly sharp	396	99	33.3	2.5	2.64
Bar in good condition, except knife one-quarter dulled	305	8	2.7	2.5	2.03
Bar in good condition, except knife one-half dulled	318	21	7.1	2.5	2.12
Bar in good condition, except knife three-quarters dulled	367	70	23.6	2.5	2.45
Bar in good condition, except knife fully dulled	398	101	34.0	2.5	2.66

[1] *Farm Mechanics*, p. 12, 1921.

plate in poor adjustment. These tests show the advantage of a sharpened knife and a properly adjusted cutter bar, with ledger plates in good condition. Figure 436 shows two types of knife grinders.

370. Side Draft.—Side draft on mowers is a tendency for the machine to pull around toward the side on which the cutter bar is placed. An extra-long cutter bar will sometimes, within itself, cause side draft because of the long leverage to the side; the average small mower may also give a certain amount of side draft. In these mowers it is usually caused by the failure to cut clean, which allows the grass to pull under and the cutter bar to slide over without cutting the grass at all. If the knife or ledger plates become dull, hard cutting will result, which, at the same time, will cause considerable side draft; but if the mower is properly adjusted and all parts in good condition, there should be very little side draft.

371. Breaking of Knives.—A common trouble in mowers is that of breaking the knives at a point where the knife-head strap ends. This trouble may be caused by badly worn knife-head holders on the inside shoe, by nonalignment, and by undue play in the pitman box bearings. When the inside shoe parts become badly worn, the knife is allowed to play up and down as the pitman draws and pushes it backward and forward. As the pitman draws the knife in, it naturally pulls the head up and when it pushes it out, the pressure is down against the plate. If there is much wear at this point, therefore, the knife head will have considerable play up and down and will, in time, break the knife bar.

Nonalignment is often considered another cause for breaking the knife because it is working at an angle.

When the pitman box bearing becomes worn, allowing considerable play within the bearing, there will be a decided jerk and pounding as the knife reaches the end of its out-and-in strokes. This will weaken the knife bar and finally break it.

372. Lost Motion.—After a mower has been used for some length of time, lost motion may occur in the parts transmitting power from the main wheel to the knife. The machine may be started forward and moved several inches without the knife starting. The places where lost motion may develop are as follows:

1. In the hubs of the wheels where the pawls engage the rachet.
2. In the clutch.
3. In the various gears.
4. In the pitman wheel bearings.
5. At the knife head.

The parts involved should be examined frequently and steps taken to eliminate as much lost motion as possible.

373. Acres Cut per Day.—The acres cut per day will naturally be influenced by several factors, such as material being cut, size of machine, condition of machine, and speed.

The *Extension Service Handbook*[1] gives the duty of a mower for a 10-hour day as 1.68 acres per foot of width of cut. It also gives 2.50 feet as the most usual width per horse.

A good day's work with a 7-foot machine is 13 to 15 acres per day.[2] With a 5-foot mower, the cost per acre for man and horse labor will be around 50 cents.

Tractor Mowers

The tractor mower is a specially designed attachment for general-purpose tractors. Design details of tractor mowers vary, as the mower

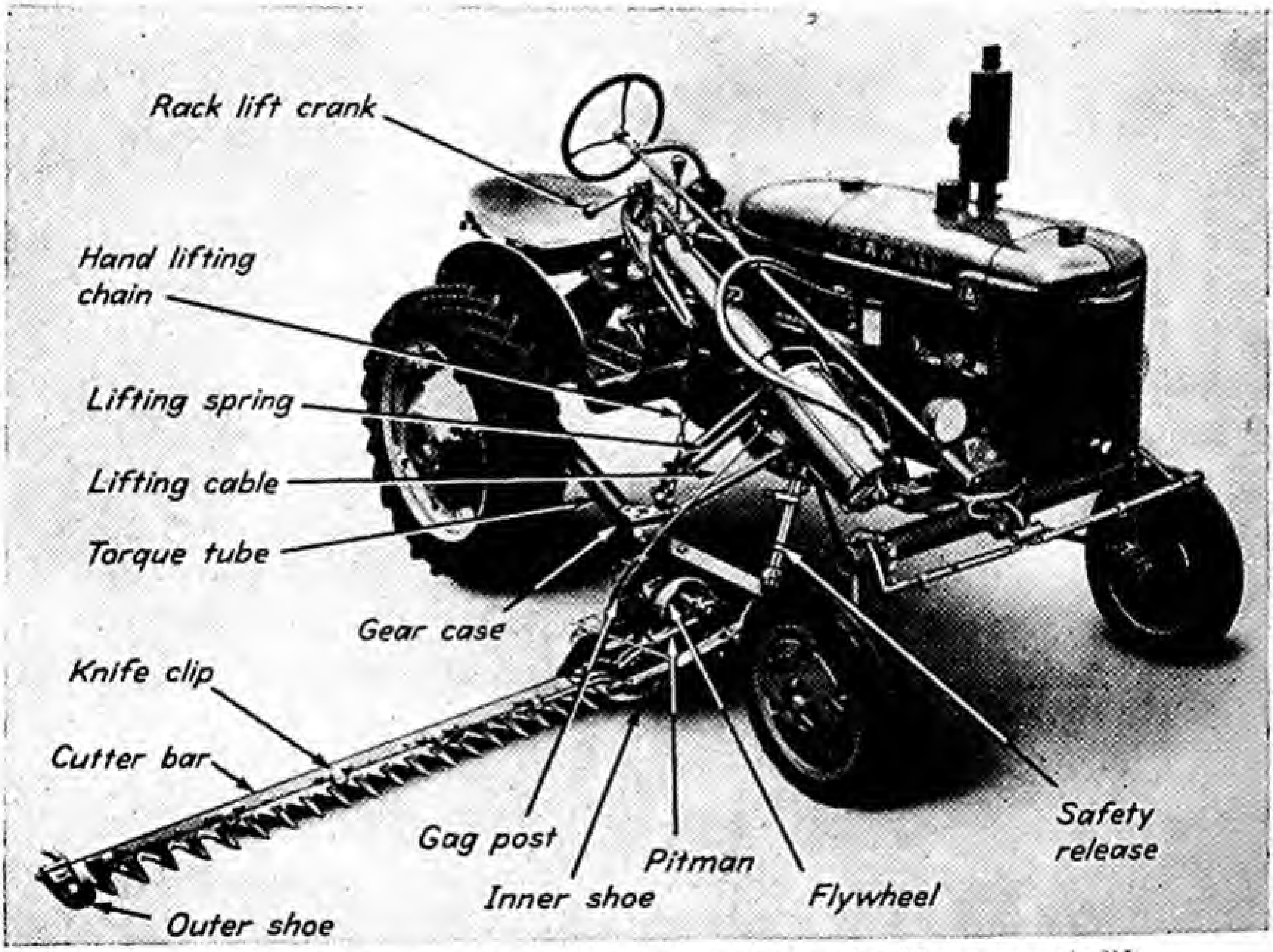


Fig. 437.—Front-mounted tractor mower equipped with pneumatic lift.

must fit different designs of tractors, but generally tractor mowers can be divided into three classes determined by the way the mower is attached to the tractor. The classes are the front- or central-mounted, the integral rear-mounted, and the direct-connected trail-behind.

[1] *Extension Service Handbook on Agriculture and Home Economics*, U. S. Dept. Agr., 1926.

[2] *U. S. Dept. Agr. Farmers' Bull.* 943, p. 8, 1921.

374. Front- or Central-mounted Tractor Mower.—This method of mounting is more generally found in connection with the smaller size tractors that are equipped with widespread front wheels as shown in Figs. 437 and 438. Tractor operators like front-mounted mowers

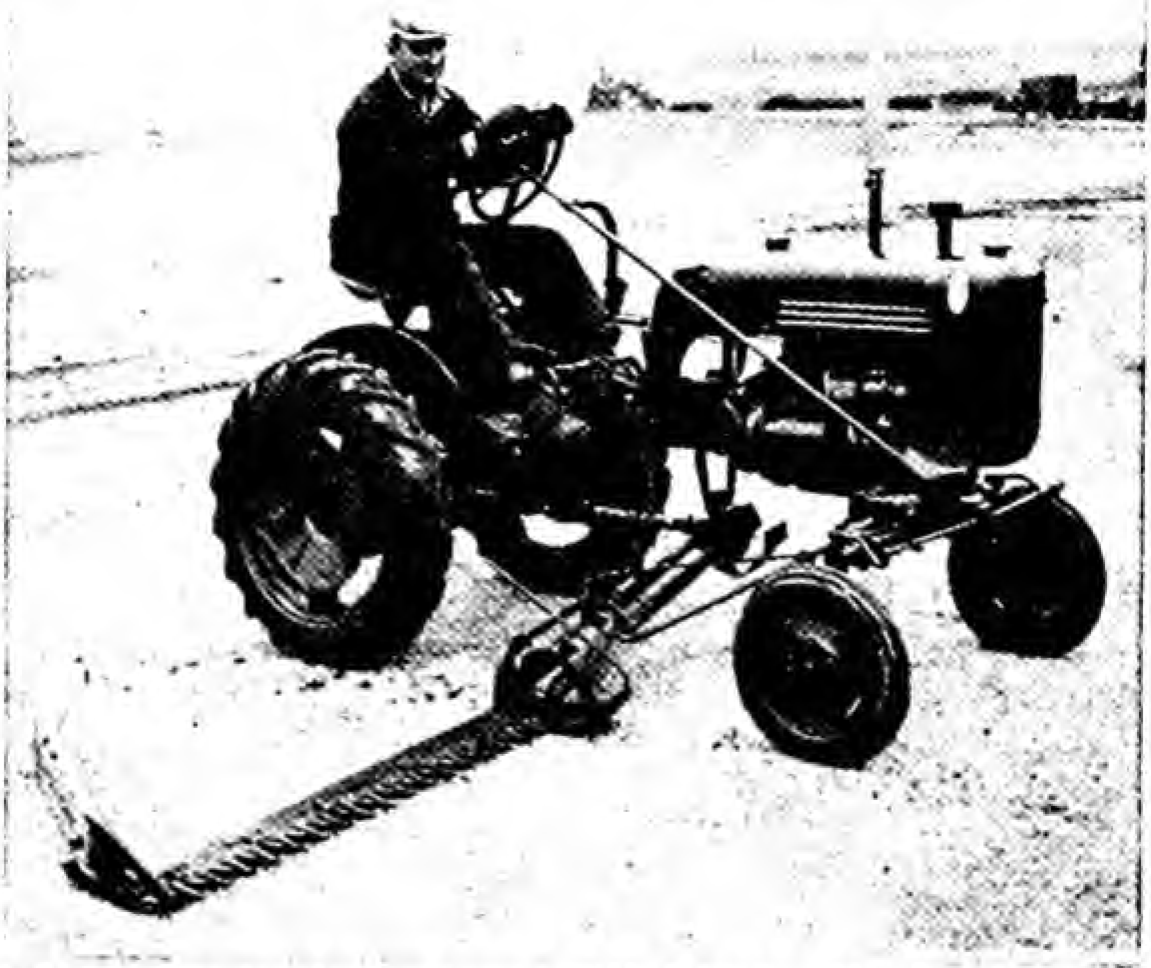


FIG. 438.—Small baby-size tractor equipped with 5-foot cutter bar front-mounted mower.

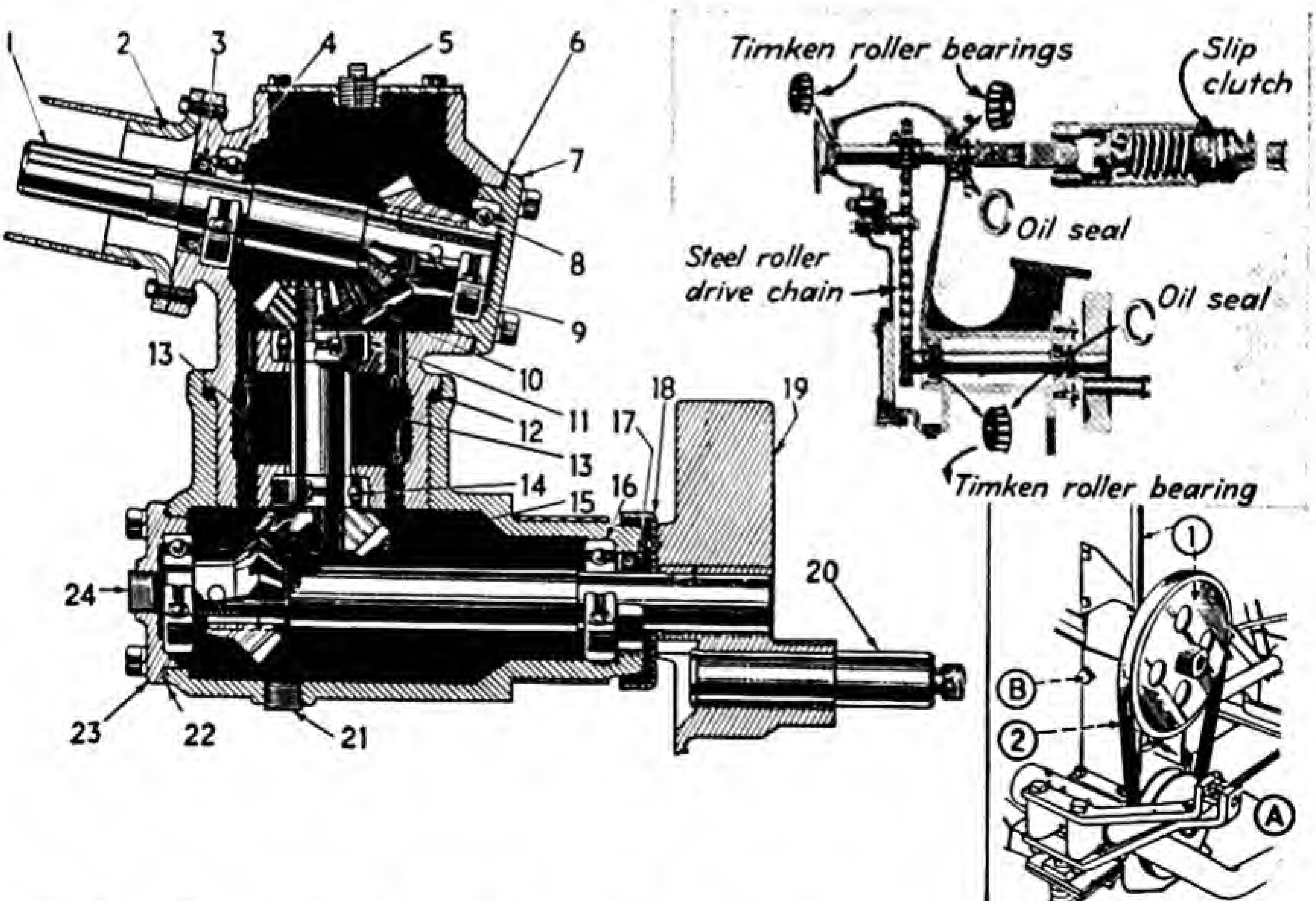


FIG. 439.—Cross-sectional views of methods of transmitting power on tractor mowers. *Left*, enclosed gears; *right top*, chain drive; *right bottom*, V-belt drive.

because they can watch the cutter bar more easily. The cutter bar is mounted on the right side of the tractor between the front and rear wheels. This arrangement makes it easy to use power lifts. Power is usually taken from the power-take-off by V-belt and transmitted to the knife through shafting, gears, and pitman (Figs. 439. 440, and 441). Automatic safety releases and snap or slip clutches are provided. Means of adjusting the alignment, registration, and tilting of the cutter bar are also provided.

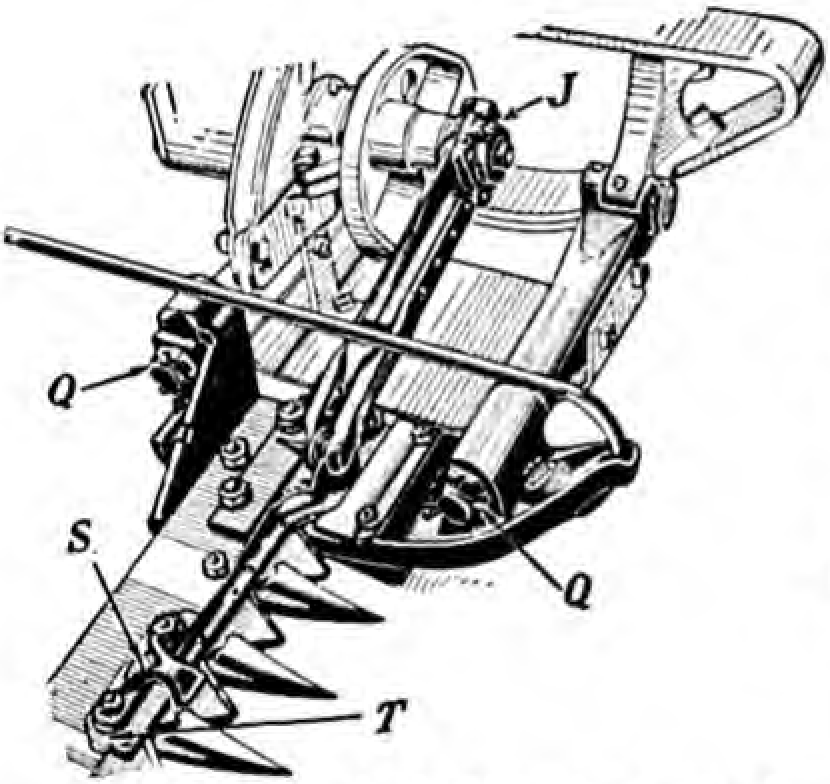


FIG. 440.—Method of hinging cutter bar to permit continuous operation of knife from a position below level to a vertical position. The bar can be tilted by adjusting nut at points Q for the mower shown in Fig. 437. Note that the hinge rod and the pitman are the same length.

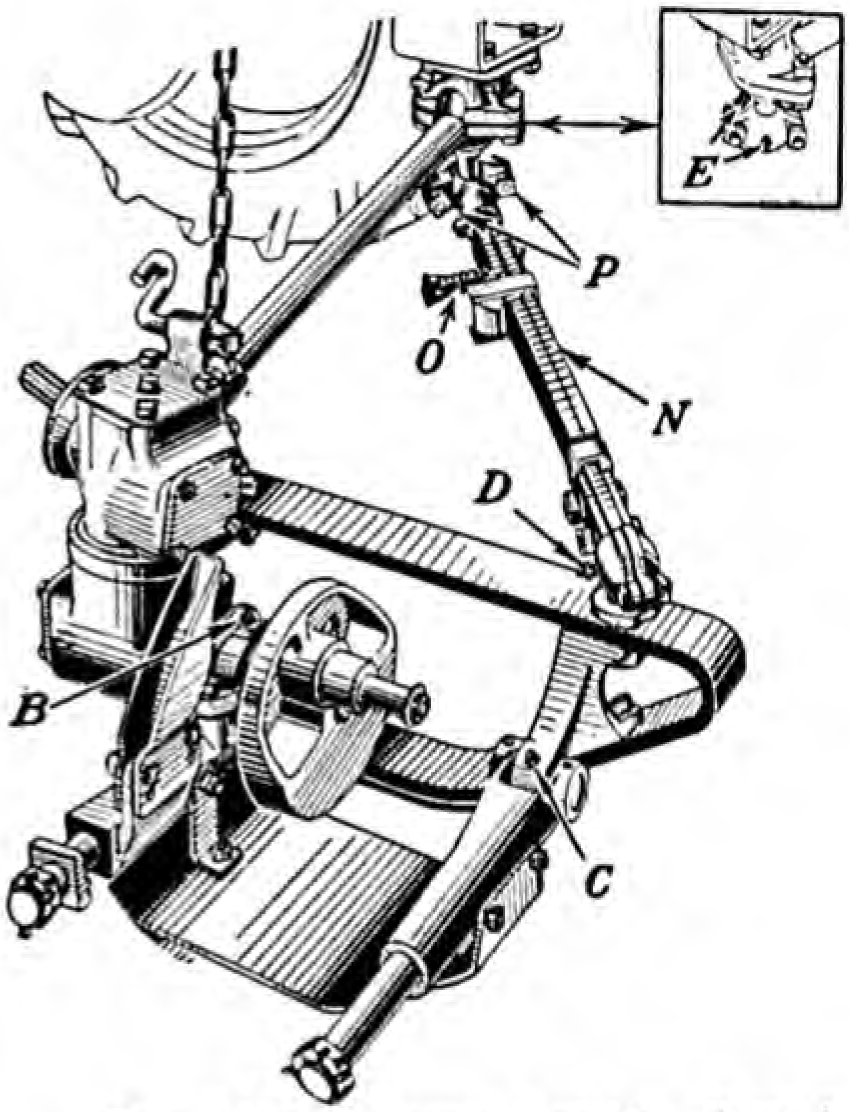


FIG. 441.—Automatic safety release is shown at N. Tension on spring O holds bar for ordinary cutting. If bar breaks back it is returned to position by backing tractor. Later models use a cable and winch to pull bar back into position.

375. Integral Rear-mounted Mowers.—This type of tractor mower is direct-connected to the tractor and is mounted on the tractor drawbar (Fig. 442). All the weight of the mower is on the tractor. The power is transmitted directly or indirectly by V-belt from the power-take-off to the pitman shaft; no gears or universal joints are required. An automatic safety release allows the cutter bar to swing back if an obstruction is hit. This safety release is connected to the tractor clutch foot pedal, and as the bar swings back it automatically disengages the tractor clutch. Provision is made for the adjustment of the alignment, registration, and tilting of the cutter bar. The cutter bar is lifted by a hand lever.

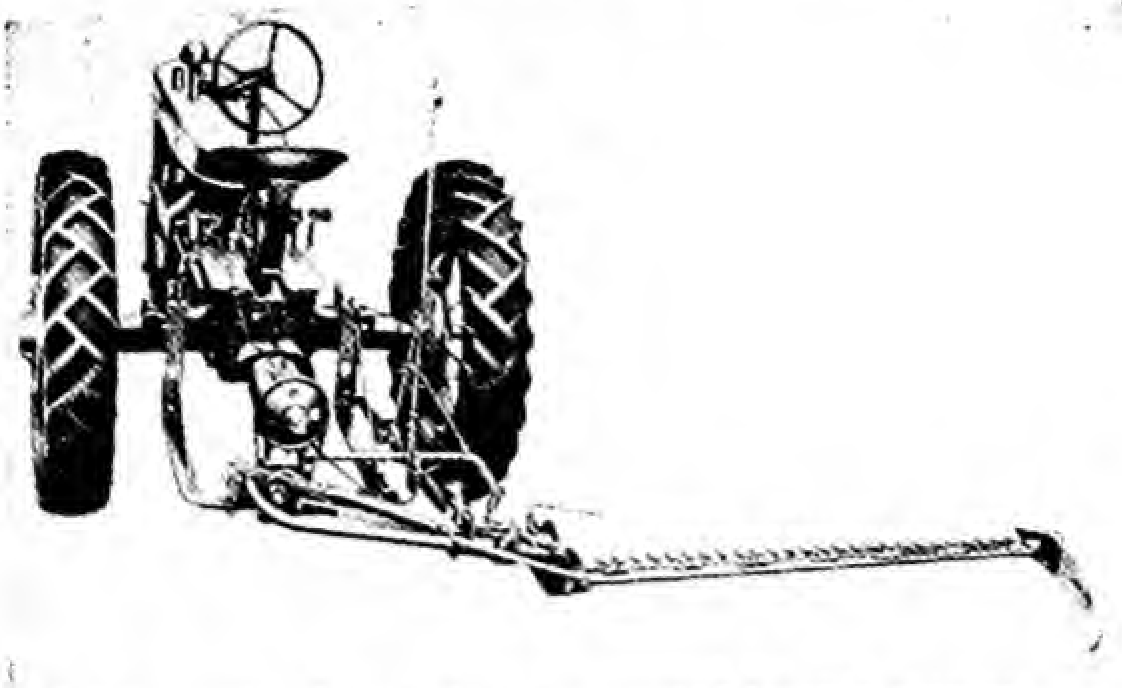


FIG. 442.—Integral rear-mounted tractor mower.

376. The Direct-connected Trail-behind Tractor Mower.—This type of tractor mower is built into a unit that can be easily attached to and detached from the tractor drawbar. A trailing caster wheel supports the mower at the rear (Fig. 443). The arrangement gives flexibility and allows the cutter bar to follow the contour of the ground. Power

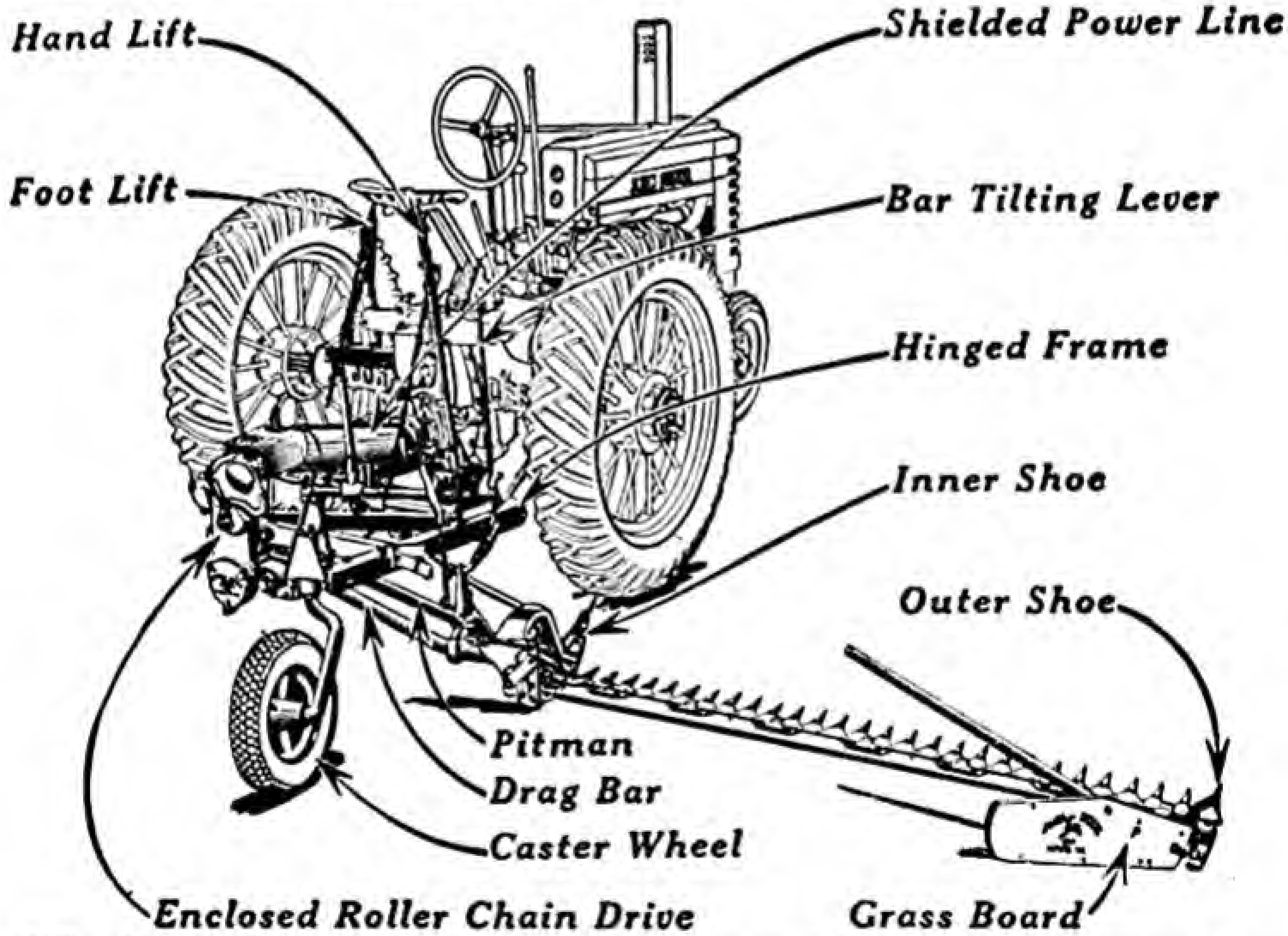


FIG. 443.—Direct-connected trail-behind tractor mower with caster wheel to support mower at rear.

may be transmitted either by gears or by chain (Fig. 439). The regular adjustment features are provided. The cutter bar is lifted by a hand lever.

377. Attachments for Tractor Mowers.—All attachments for horse-drawn mowers can be used on tractor mowers. The high cutting wheels shown in Fig. 444 can be used on all types of mowers.

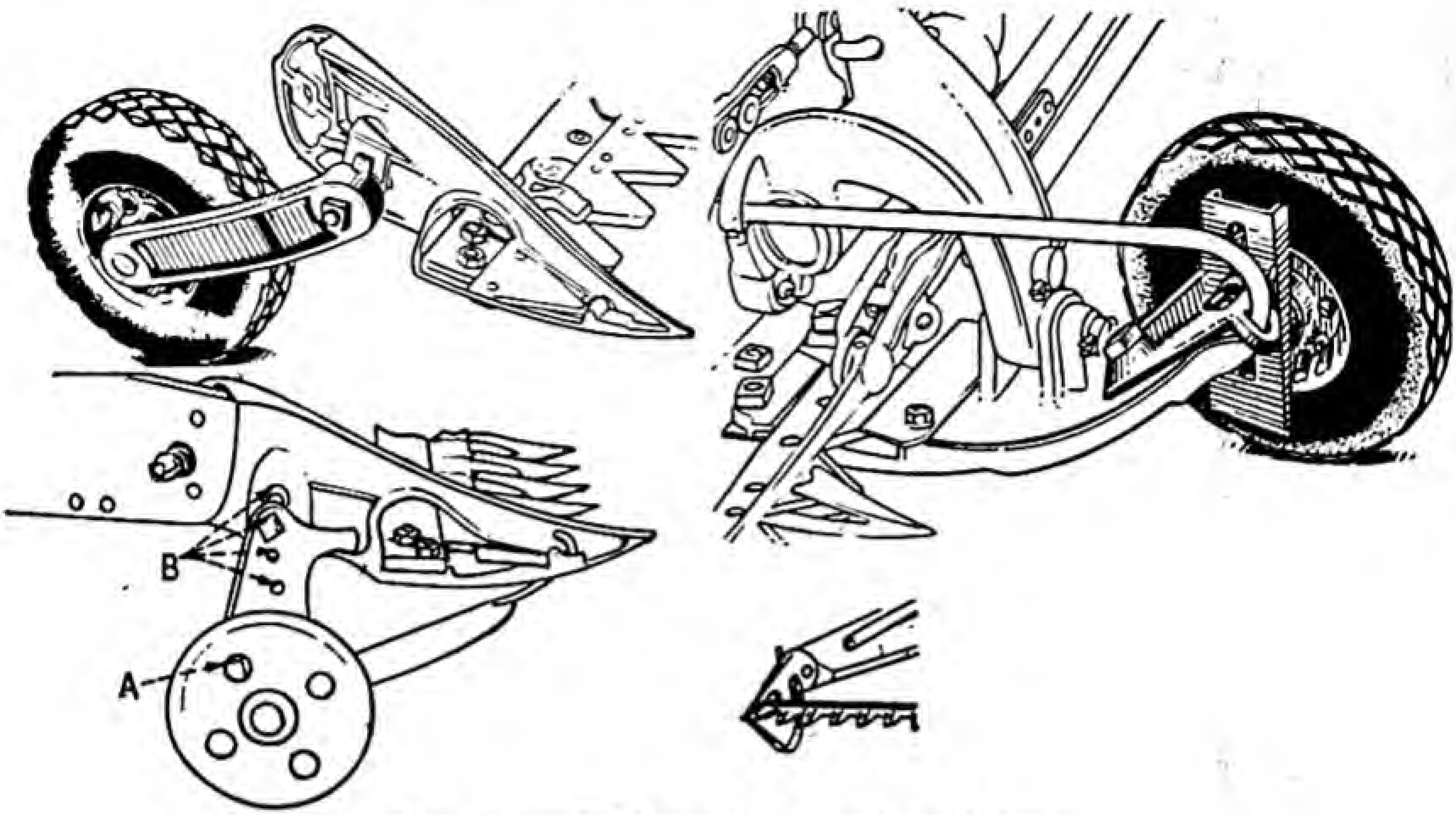


FIG. 444.—High-cutting wheels and shoes.

HAY RAKES

Hay rakes may be classified as dump, side-delivery, and bunching rakes.

378. Dump Rakes.—This type of rake, shown in Fig. 445, is also known as a *sulky* hay rake. The principal difference between a hand-dump rake and a power-dump rake is that with the former the operator must furnish the power for lifting the teeth to dump the hay, while in the latter the operator merely presses a small foot lever which engages pawls in the hubs of the wheels. Then, as the rake is drawn forward, the power

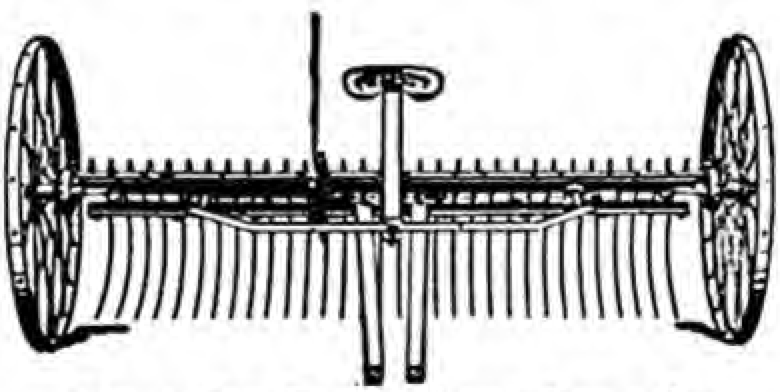


FIG. 445.—Power-dump hay rake.

furnished by the team lifts the teeth. The pawls are automatically released when the teeth have been raised. Specially constructed dump rakes may be had for use in orchards to rake up the branches or trimmings after pruning. Some farmers of the Middle West are building dump hay rakes to take a 30-foot swath. A braking system in the hubs of the wheels dumps the rake.

379. Side-delivery Rakes.—The use of hay loaders and pickup hay balers created a demand for a hay rake that would make a loose, fluffy, continuous windrow. Then, too, many haymakers are raking the hay

into windrows directly after it is cut. Such windrows must necessarily be loose to allow the hay to cure. The side-delivery rake was developed to take care of this demand. It is also used to windrow peanuts.

This type of rake consists of a cylinder of three to four rake bars placed at an angle of about 45 degrees with the direction of travel (Figs.

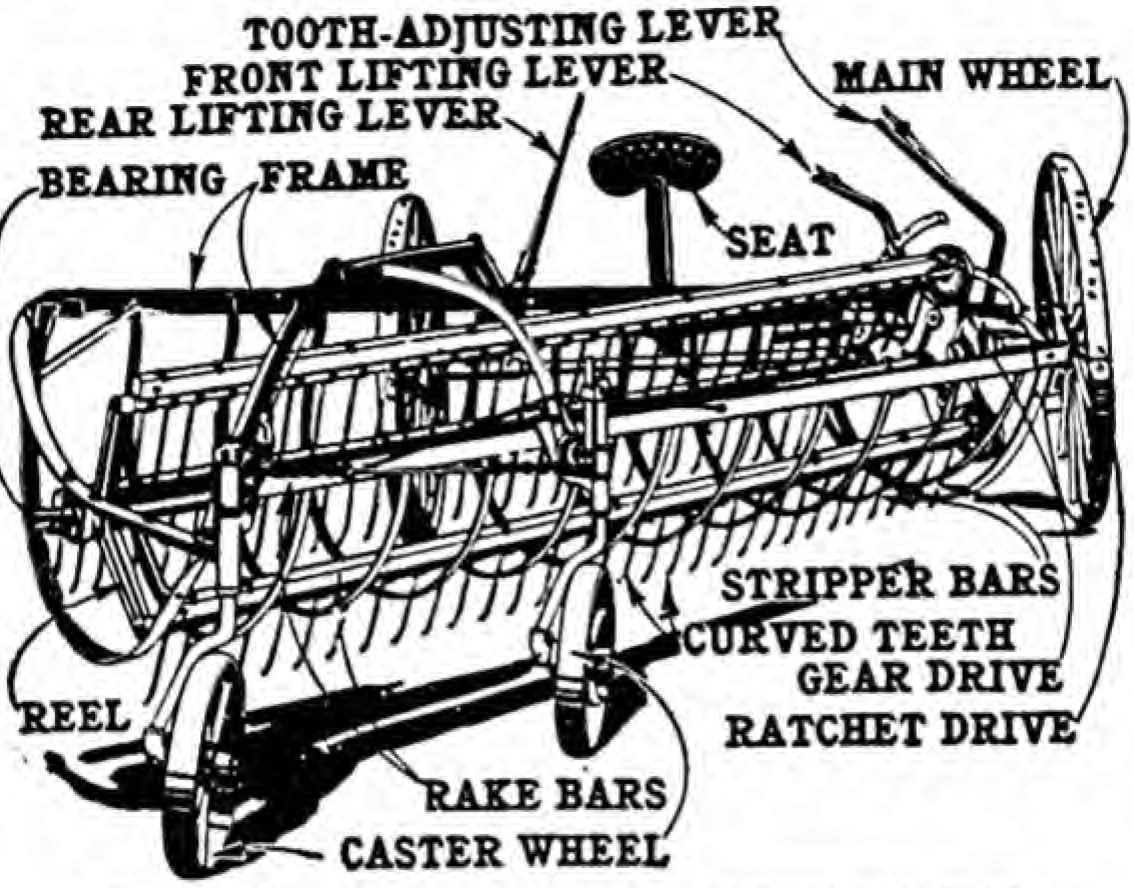


FIG. 446.—Cylinder-type side-delivery hay rake.

446 and 447*a*). The delivery is made to the left so that the direction of travel is the same as that of the mower. This makes the rake teeth work against the heads of the hay, rolling them to the inside of the windrow and leaving the juicier stems on the outside. Some side-delivery rakes are constructed so that the rotation of the cylinder can be reversed and the rake can be made to do the work of a hay tedder.

FIG. 447*a*.—Tractor pulling two side-delivery rakes windrowing hay for a pickup hay baler.

Power is transmitted from the axle gears or from a combination of chain and gears. Much trouble is caused by sand collecting on exposed gears and chains, causing them to wear rapidly. They should be enclosed. Heavy-duty four-bar rakes are available. The cylinder is suspended from

two heavy frame bars. Provision is made for changing the angle of the teeth. A power-take-off-driven side-delivery hay rake has been recently developed. It has two speeds for raking, and the reel can be reversed for tedding.

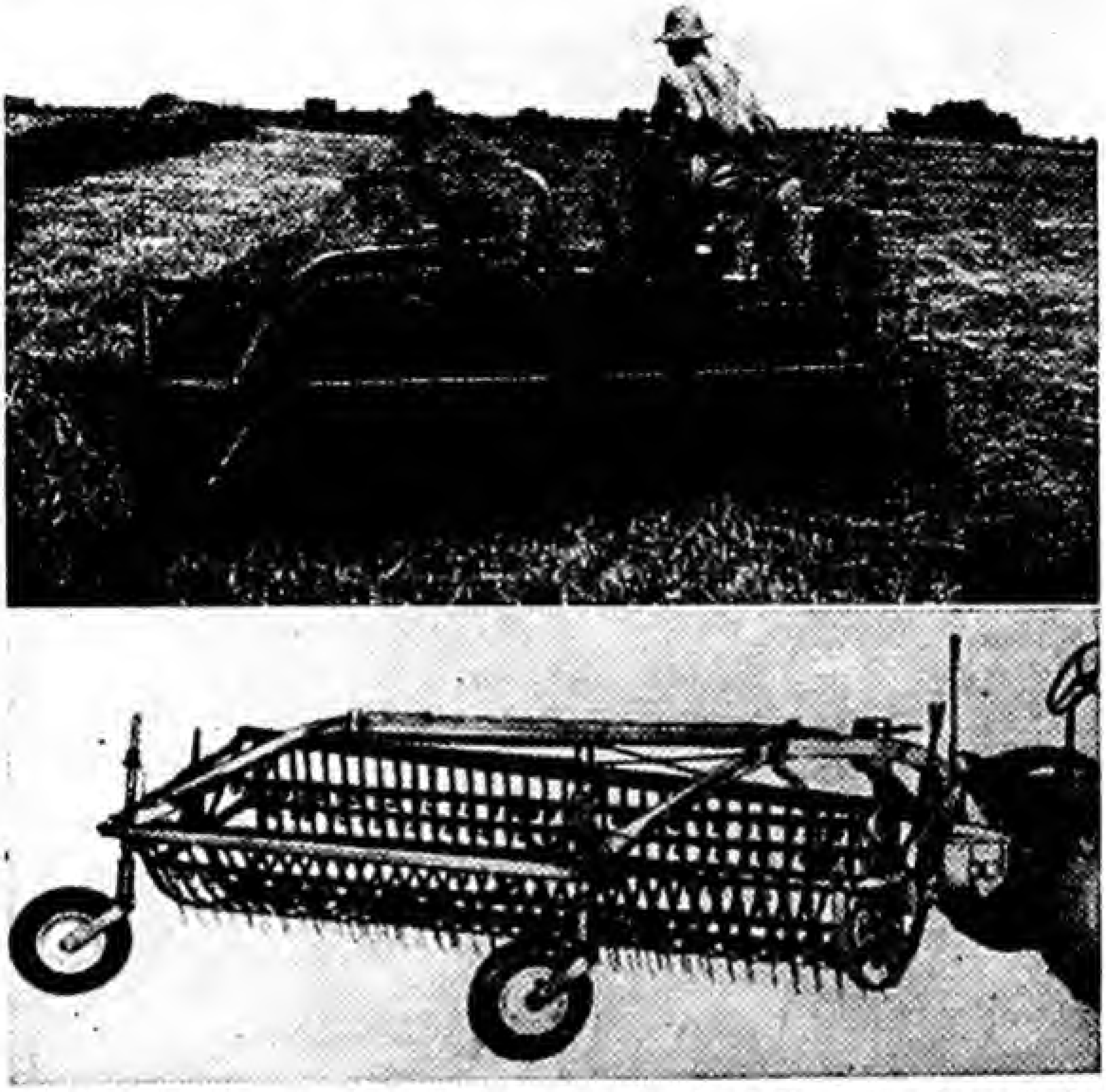


FIG. 447b.—Top, direct-connected tractor-drawn side-delivery rake windrowing a heavy layer of hay. Bottom, shows how rake is connected to tractor.

380. Bunching or Sweep Rakes.—For the rapid handling of the hay from the windrow to the bailing press or stack, a bunching or sweep rake, sometimes called a *buck* or *bull* rake, is a labor and time saver, as well as a cost-reducing tool. There are several kinds of sweep rakes.

The *side-hitch* sweep rake has one horse hitched on each side of the machine beside the teeth. The teeth are 7 or 8 feet in length, placed about 1 foot apart, and are made of wood. These long teeth are lowered upon the ground and slide under the hay until a load has been collected. Then, in most cases, the teeth and hay are raised off the ground, the whole weight being carried on the wheels.

The *two-wheel* type allows the operator to slide the seat backward and forward to help balance the rake teeth and the load.

The *three-wheel* type, shown in Fig. 448, has the seat mounted on a rear truck consisting of one wheel which swivels in any direction. A lever is provided to raise and lower the teeth.

In the *rear-hitch* sweep rake the team is hitched back of the rake head. The rear truck supporting the seat and eveners may have one or two

castoring wheels. Figure 449 shows a four-wheel rear-hitch type. The horses are hitched at the rear, one on each side of the truck.

The rear-hitch sweep rake is better suited for heavy hay and is so constructed that it will pass over small irrigation ditches without difficulty. However, some haymakers prefer the side-hitch type for rough ground.

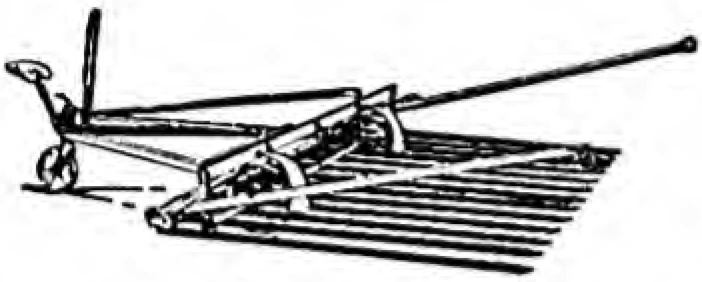


FIG. 448.—Side-hitch three-wheel sweep rake.

FIG. 449.—Rear-hitch four-wheel sweep rake.

Many rear-hitch sweep rakes are provided with power-lifting devices so that the operator is not required to lift the rake teeth and hay entirely by hand levers; after the teeth have been raised by the power device, they are automatically locked in place so that the hay can be carried some distance.

351. Tractor Sweep Rakes.—Sweep-rake teeth can be mounted on the front of the tractor (Fig. 450). The raising and lowering of the teeth are operated by power from the tractor.

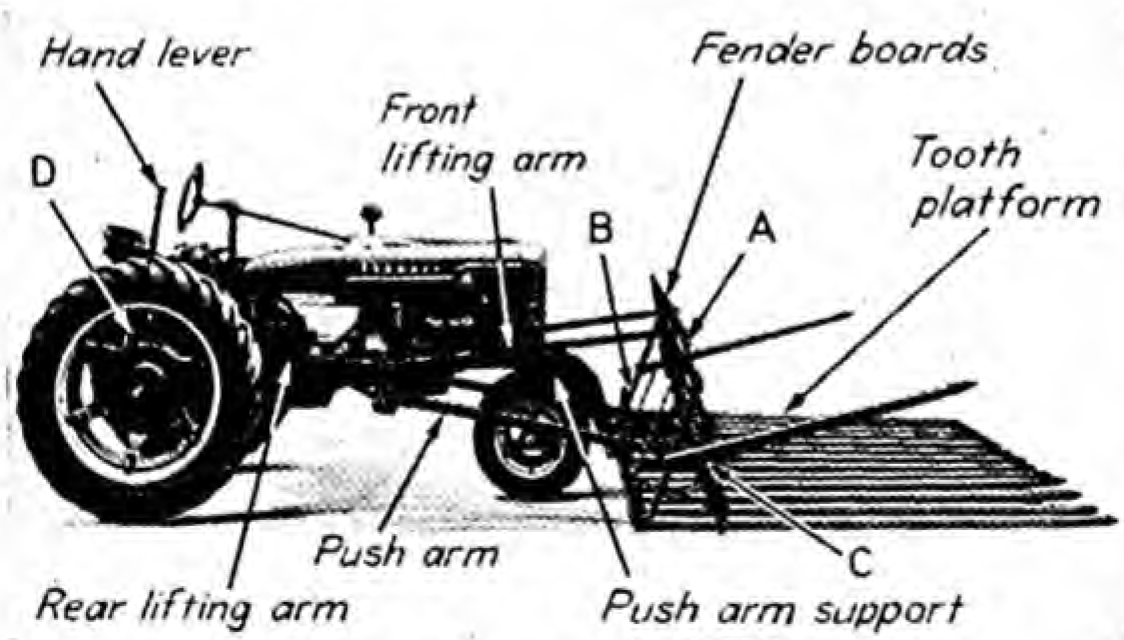


FIG. 450.—Tractor-mounted sweep rake.

HAY LOADERS

To facilitate the rapid handling of hay and to eliminate a great deal of manual labor, the hay loader was brought out for taking the hay either out of the windrow or directly out of the swath and elevating it up onto the wagon.

There are two general types of hay loaders, the *cylinder carrier*, which may be single or double, and the *rake-bar* or *fork* type. These machines are attached to the rear of the wagon and driven over the windrow or

along the swath from which they gather the hay, loading it onto the wagon. Loaders may be had with or without a forecarriage. If no forecarriage is used, the machine is balanced on two drive wheels and the front part is carried by the rear axle of the wagon.

It is claimed that a hay loader,[1] under ordinary conditions, will increase the capacity of a crew about 30 per cent over that of the same crew pitching the load by hand forks.

382. Fork Loader.—The loader shown in Fig. 451 is often called a *swath* loader because it is not necessary to rake the hay before using the machine. It will rake and load hay all in the same operation. It will, however, do good loading from the windrow. This loader has two sets of wooden bars operated alternately by a cranking motion from the drive wheels. At the end of each of the wooden bars are clawlike rakes that

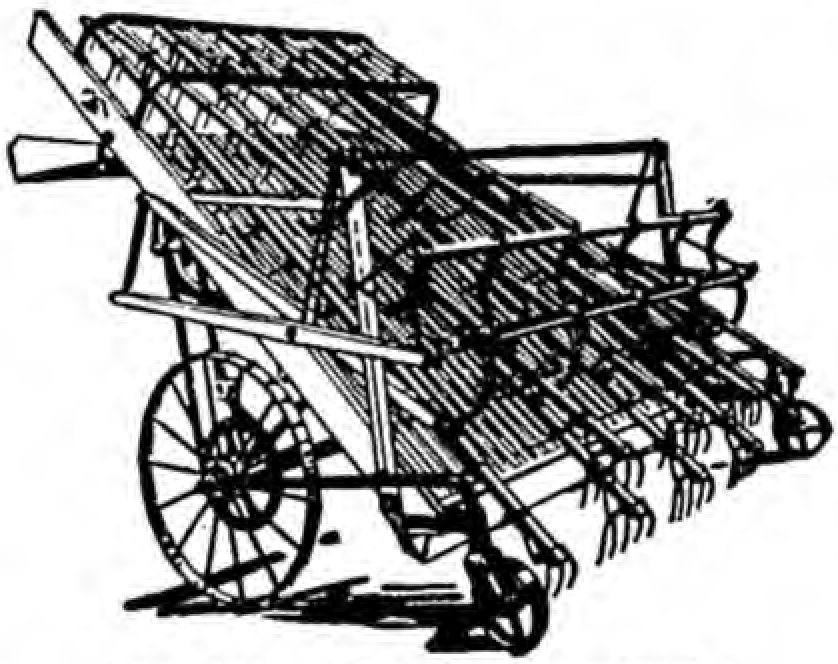


FIG. 451.—Fork-type hay loader.

gather the hay from the windrow or swath, pulling it up on a slatted inclined apron which extends up over the rear of the wagon or rack. At intervals along each of these bars are flexible-wire teeth which extend downward to catch the hay and move it up the incline as the bars are worked backward and upward. While one set of these rake bars is gathering the hay from the ground and pushing that already gathered up the incline, the other set is raised upon its crank above the hay and moved back down for a new movement upward. The hay is pushed little by little up the incline until it falls on the load.

383. Cylinder Hay Loader.—This type of loader, shown in Fig. 452, is often known as the *windrow* loader, *endless apron*, *elevator*, *belt*, *web*, or *drum* type, so called because of the cylinder for gathering the hay and the elevator for elevating it.

The cylinder consists of a number of shafts rigidly fixed and placed an equal distance apart around the circumference of the cylinder head.

[1] McCLURE, H. B., Hay Making, *U. S. Dept. Agr. Farmers' Bull.* 943, p. 16, 1921.

Upon each of these shafts are tinelike teeth having a peculiar curve and given three or four turns around the shaft for flexibility. This cylinder revolves in the same direction that the drive wheels are revolving, and

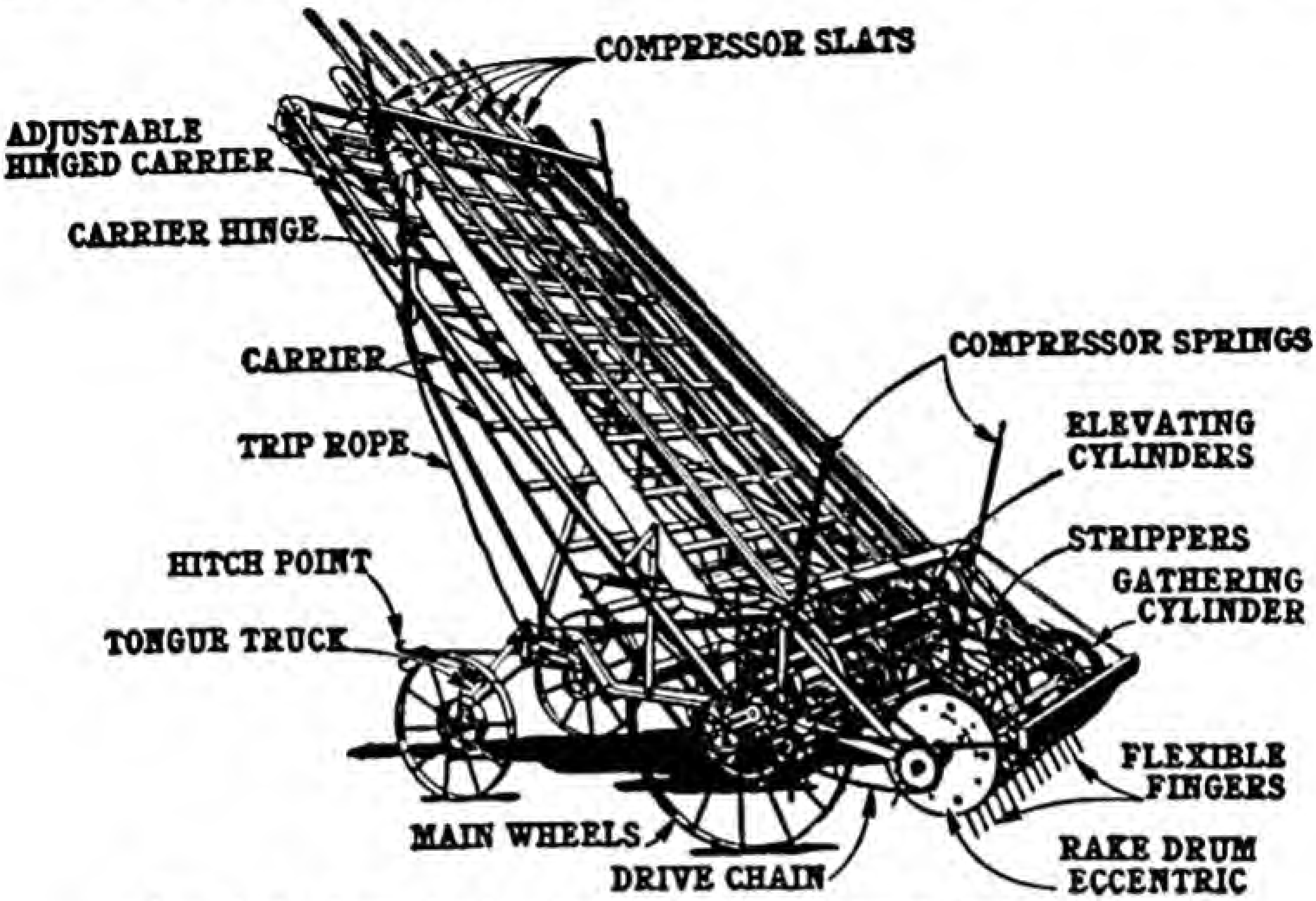


FIG. 452.—Cylinder hay loader with gleaning cylinder attached.

the teeth have an action similar to that of an ordinary hand pitchfork, bringing the hay up and over from the rear, depositing it on the web-slatted apron, which elevates it on to the wagon. The elevator or apron is made up of wooden slats placed about 12 inches apart, connected by strands of rope and driven by chains at either end from the main drive wheel below.

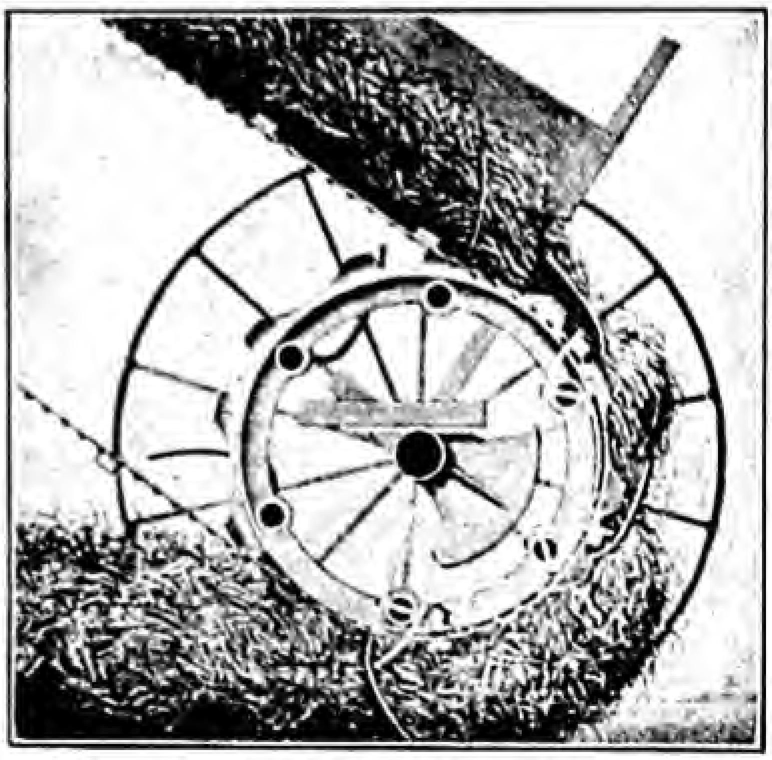


FIG. 453.—How the cylinder-type hay loader picks up hay and deposits it on the elevating carrier.

When the loader is attached to the rear axle of the wagon, there should be an automatic release which can be operated from the top of the load by pulling a trip rope, thus saving time because it is not necessary to get down off the load and unhook the loader.

384. Gleaning Cylinder.—To make sure that the hay is raked clean from the windrow, another cylinder is attached to the rear of the main raking cylinder to act as a gleaner. This may be called a *double-cylinder* loader (Fig. 452). This auxiliary cylinder revolves in a direction opposite

to that of the main cylinder and does a good job of gleaning the hay left by the main cylinder.

385. Combination Cylinder and Rake bar Loader.—This hay loader combines the principles of both the cylinder and the fork or rake-bar loaders. It retains the rake bars for elevating the hay but makes use of a cylinder for picking up the hay from the windrow (Fig. 454). The tight bottom prevents loss of shattered leaves, and the rake bars permit satisfactory loading in windy weather.

FIG. 454.—Combination cylinder and rake-bar hay loader in operation.

386. Hay Racks.—For hauling hay to the barn or stack, special hay wagons or racks are necessary. It is not possible to use the ordinary wagon box for hauling a great amount of hay because only a small quantity can be loaded on. For this reason a frame is built to set on the wagon gears. It extends to the side over the wheels and is much longer than the ordinary wagon box. At each end of this rack are placed frames which are inclined outward. Such frames will accommodate twice as much hay as can be put on an ordinary wagon box. This type of hayrack is used to a considerable extent in all the hay sections. They either can be bought commercially or can be built locally. Some of these racks have boards or slats on the sides for the hauling of short hay where there is considerable wind.

There is a second type of hay rack which, instead of being placed on an ordinary wagon gear, is mounted on wheels and is often called a *hay truck*. The truck wheels are about 15 inches in diameter, so that the whole outfit is rather low. Some of these types of trucks have four wheels, while others have only two placed near the center so that the truck

balances. A series of trucks can be attached together, each supporting the other. Such trucks are useful in sections of the country where there is heavy rainfall. The hay can be thrown on the trucks before it is cured and run under a shed out of the rain, or a tarpaulin can be thrown over it to protect the hay.

HAY STACKERS

In some sections hay is stacked in the field rather than stored in the barn. Many types of stackers are built both commercially and locally.

387. Overshot Stacker.—The overshot stackers (Fig. 455) are so called because the hay is carried up and over the stacker frame and

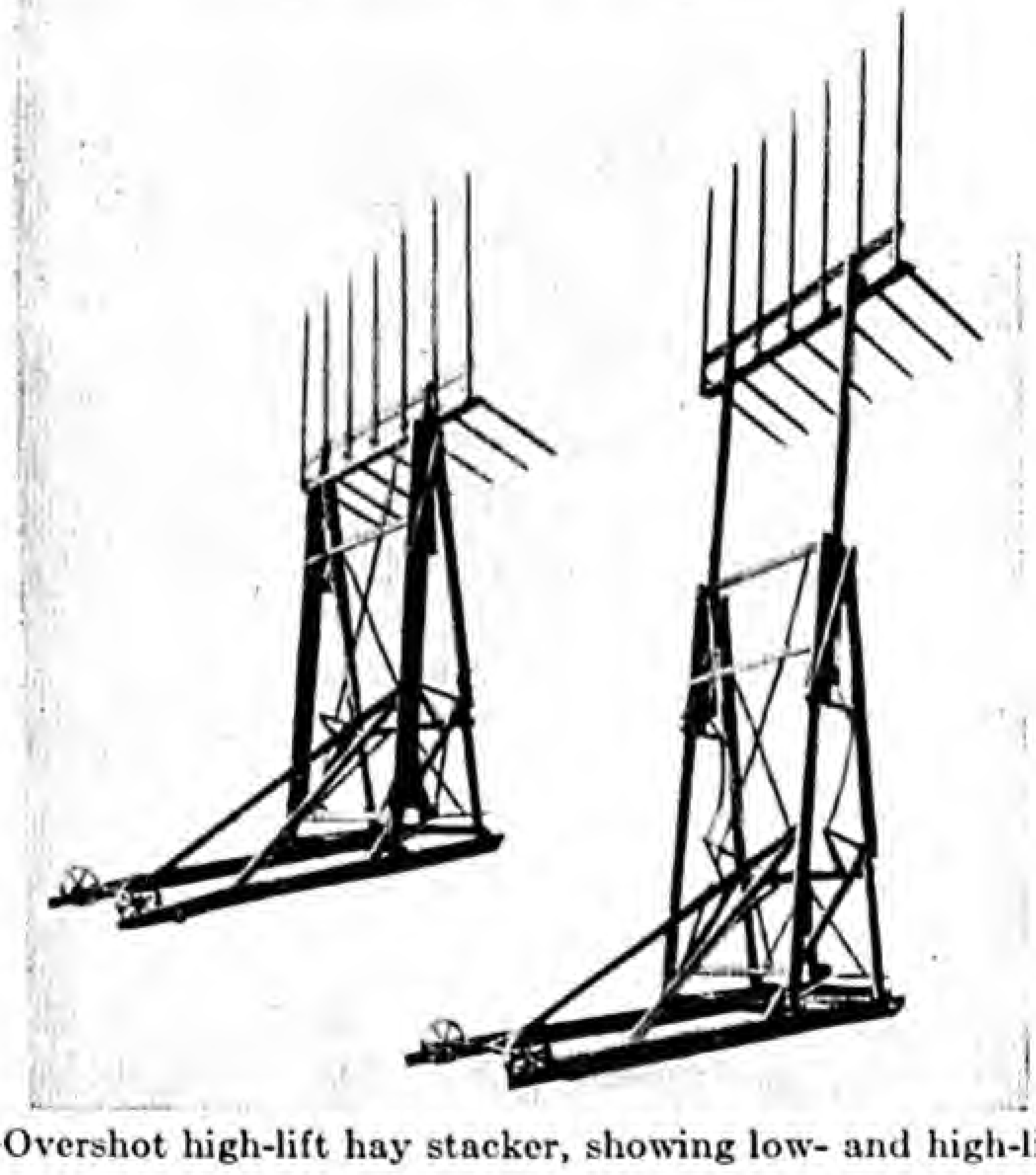


FIG. 455.—Overshot high-lift hay stacker, showing low- and high-lift positions.

delivered to the stack in very much the same way as the average man handles the pitchfork. The hay is brought up by the sweep rake; the stacker teeth are lowered to the ground and the rake teeth are driven with their load of hay to lap upon those of the stacker teeth. The sweep rake is then backed off, leaving the hay upon the stacker teeth where it can be elevated to the stack without any further trouble or handling. After the stack has become quite high, it is necessary that a considerable amount of hay be handled by hand to get it in position after being placed on the stack. This type of stacker may have a rigid frame extending from the side next the stack out to the stacker teeth, the whole of which is raised rigidly by means of ropes and pulleys. Another method is to have an

incline which may be mounted upon wheels or on a wagon gear for elevating the stacker teeth. The stacker should be provided with springs or weights to counterbalance the weight of the stacker head while the latter is returning to the ground. This allows the team to be backed as rapidly as they will without having to consider the return of the stacker head.

388. The Swinging Stacker.—This stacker (Fig. 456) is sometimes known as the *swing around* stacker. Instead of throwing the hay directly overhead it is raised and swung around to the side, where it is dropped at any place desired. This is quite an advantage over the overshot stacker. It reduces the amount of work required on the stack. The stacking head receives the hay from the sweep rake in the same manner

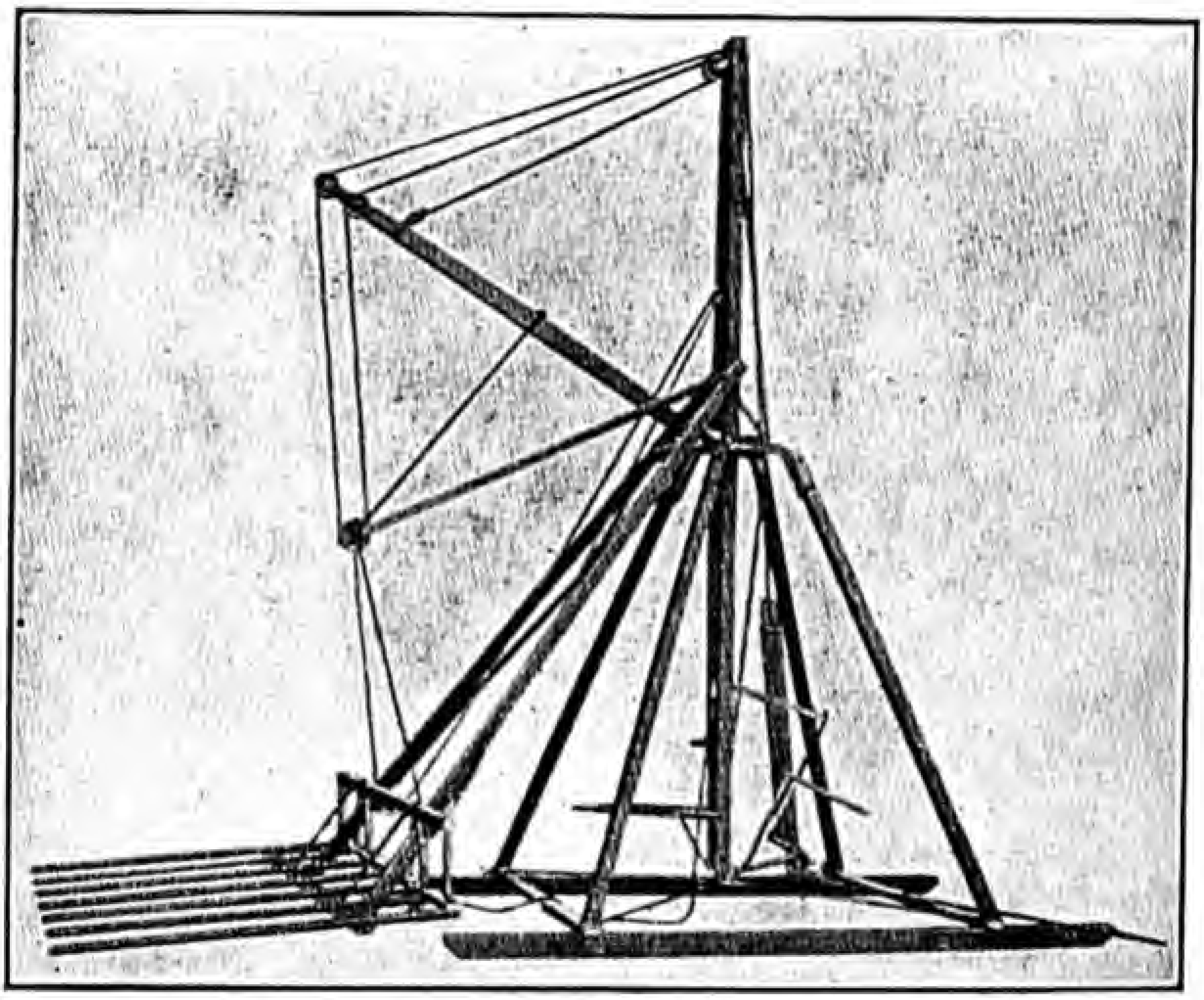


FIG. 456.—Swinging hay stacker.

as that of the overshot stacker. This type of stacker is also advantageous where there is considerable wind, which would interfere with the performance of the overshot type.

When it is desired that the load be dropped, a trip lever is pulled which allows the teeth to be tipped downward, dropping the hay in the desired place. When beginning the stack, it is necessary to elevate the hay only a few feet and, as the stack increases in height, the load can be hoisted to a corresponding height.

389. The Combination Stacker.—The combination stacker (Fig. 457) consists of both a sweep rake and a stacker combined. It is used to take the hay from the windrow or cock and place it directly on the stack. The advantage over the overhead stacker is that the hay can be dropped at any convenient place on the stack.

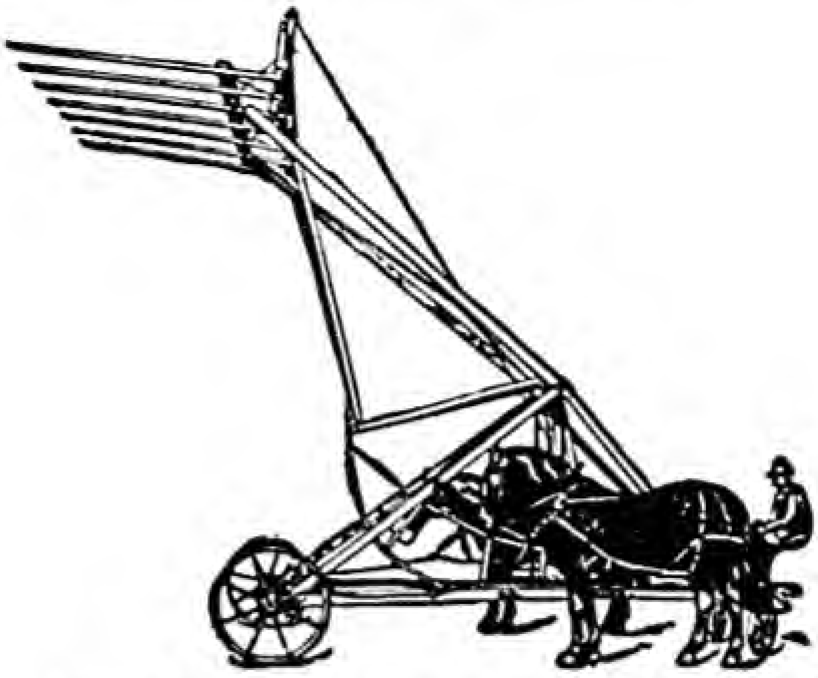


FIG. 457.—Combination sweep rake and stacker.

390. The Cable Stacker.—The cable stacker, shown in Fig. 458, consists of two sets of two poles bolted together at the top and spread out at the bottom to form a framework for the cable to be stretched over and between. The cable forms a carried track so that the hay can be carried to any place across the top of the stack. This is a similar arrangement to what is had in the barn. Any height of stack can be built. The only limiting factor is the length of the poles used.

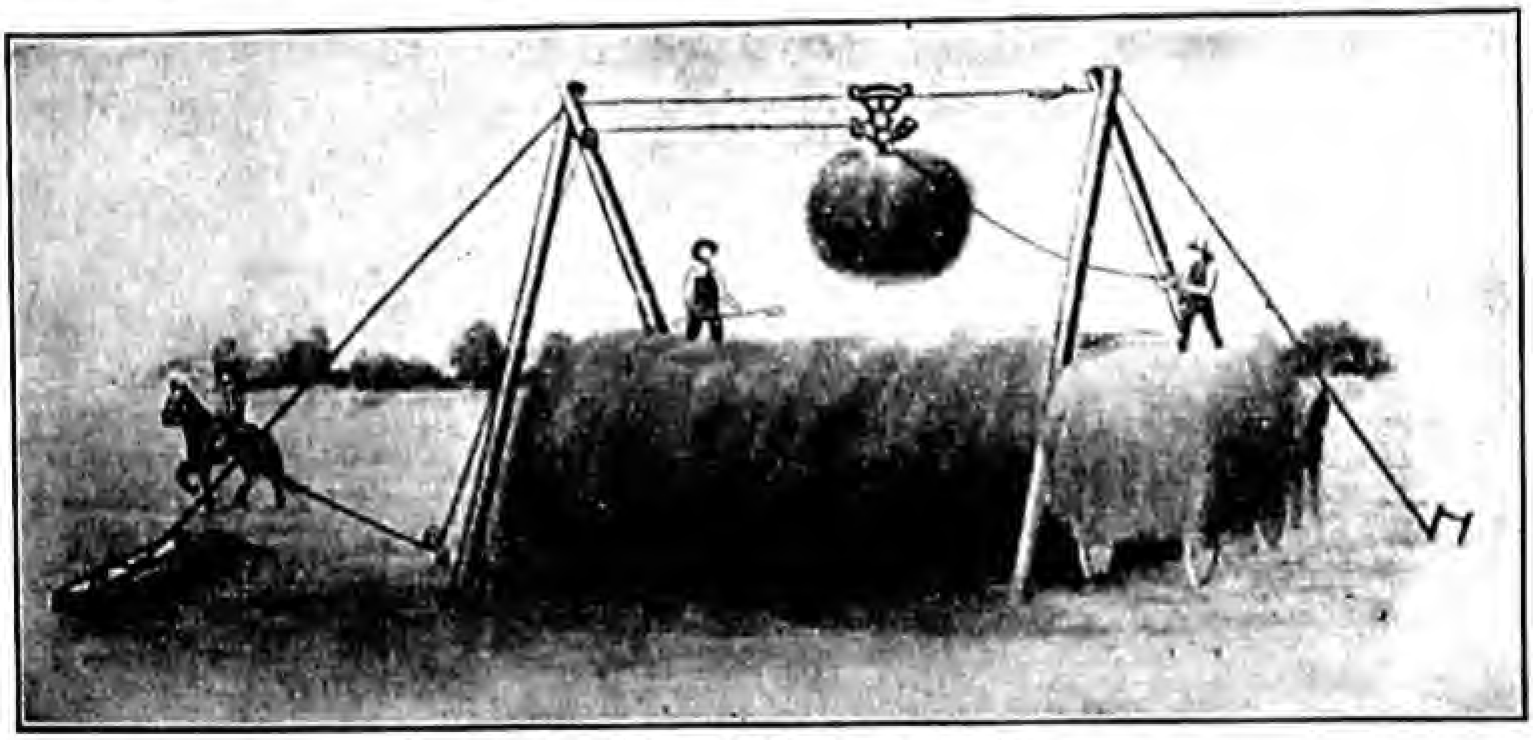


FIG. 458.—Cable hay stacker.

391. Derrick Stacker.—Such stackers may consist of one or two poles. The single-pole stacking outfit may have the pole placed in a leaning position so that the upper end will be above the stack. The pole can be set vertically with a crossarm at the top extending out to the side from which the forks are suspended for elevating the hay. In this type, it is only necessary to turn the pole or derrick through 180 degrees to handle the hay. When turned away from the stack, it is in position to take the load and, when elevated, it is swung around in a semicircle over the stack where it is dumped.

The leaning type has an advantage over the perpendicular pole, in that it can be swung to any position along the stack. This will eliminate, largely, the handling of the hay on top of the stack.

392. The Tripod Stacker.—This stacker is a very simple arrangement consisting of three poles arranged to form a tripod and supporting each other; guy wires are not necessary to hold the poles in place. A pulley is suspended from the top, where the poles are bolted together, for the elevation of the hay.

HAY BALERS

Where hay is being grown for commercial purposes and has to be shipped, it should always be baled so that as much as possible can be put into the average railway car. Many hay growers prefer to bale their hay and store it away in the barn to conserve space. Hay balers may be divided into two classes according to the power used, horse balers, which may be one- or two-horse, and power balers, which either have power in the form of a gas engine mounted on the frame or receive their power from other sources by means of a belt. Power balers are also named according to the number of men required to operate them, as one-, two-, or three-man presses. The one-man baler is an automatic self-tying press.

393. Horse Balers.—When horse power is used, no matter whether it be the one- or two-horse type of baler, the horses are hitched to a long

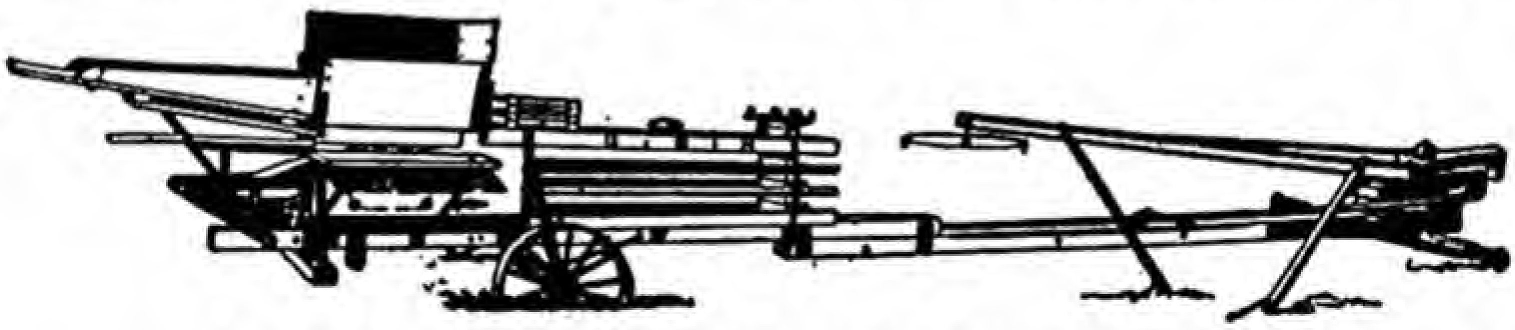


Fig. 459.—A one-horse pull-type hay press ready for use.

lever pole called a *sweep* and are required to travel in a circle to operate the compressing mechanism (Fig. 459). Some balers have long pitmans and operate by pushing the hay into a box. These are called *push plunger* balers. Others accomplish the same results by pulling and are called *pull plunger* balers. The pulling type is considered better; it eliminates quite a bit of heavy construction. In some horse balers there may be two strokes of the compressing mechanism to one complete round of the team, while in others there may be three. The more strokes to the round, the more rapid the baling process will be. Many of these small horse-power balers are fed by hand, the hay being pressed down into the compressing chamber by hand power. In others the power is supplied by the horses, and there is a special arm and feeder head to press the hay

down into the box. Along with the self-feeder device there should be a *tucker*, which prevents the bale from having what are known as *tails*.

394. Power Balers.—Balers that are run by engines are built much heavier than the horse balers (Fig. 460). An average 6-horsepower engine will do good work in operating a hay baler (Fig. 461). If a

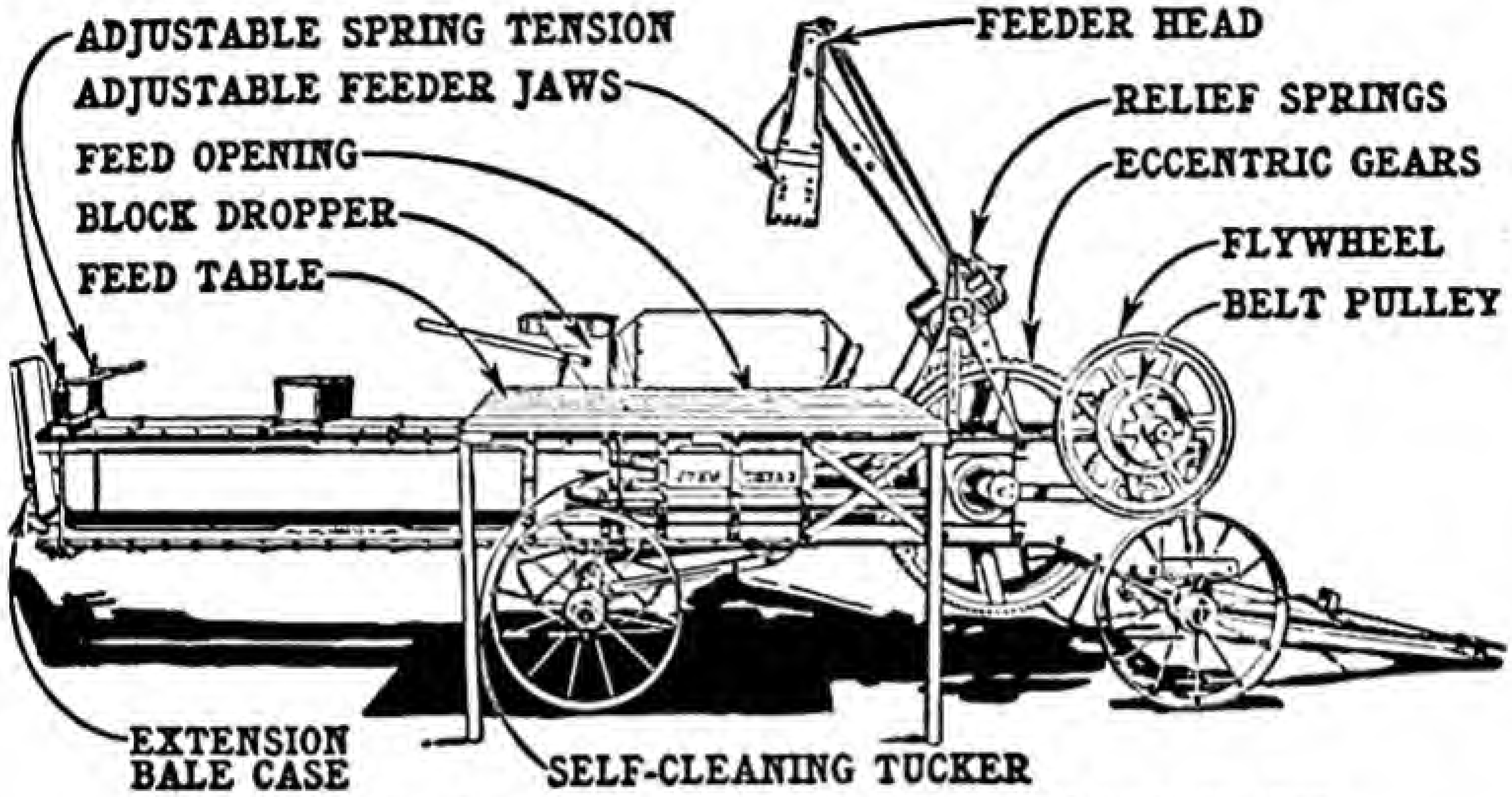


FIG. 460.—Stationary hay baler powered by belt from tractor.

machine is purchased with the engine mounted on the frame, it should be ascertained that the gas engine can be removed to be used at other jobs when not required to run the hay baler. All power balers compress the hay by the use of a pitman and plunger head. The power from the engine to the baler is usually transmitted by a belt.

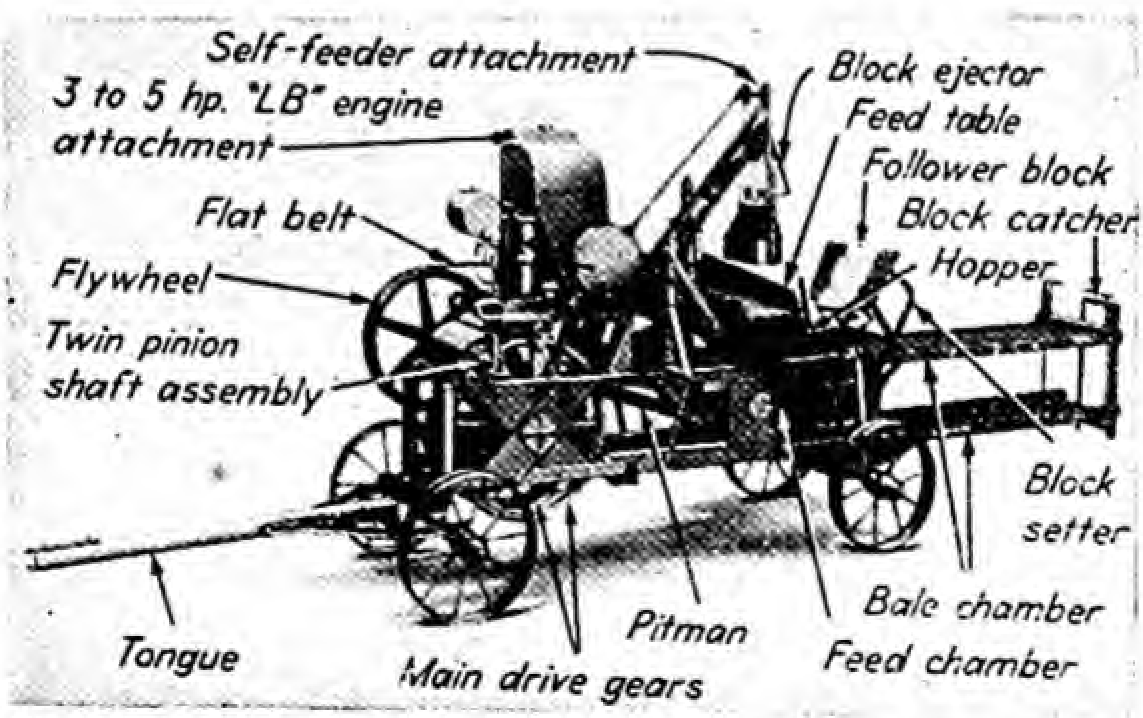


FIG. 461.—Stationary baler equipped with 3- to 5-horsepower gas engine and self-feeder attachment.

395. Self-feeder.—All power balers are provided with self-feeding devices (Fig. 461). These are operated mechanically and are so timed that when the plunger is retarded the feeder is forcing the hay down into the baling chamber. As the plunger comes back, the feeder is

raised up out of the way and remains up long enough for a fresh supply of hay to be pitched into the hopper. The speed of the engine and the gearing will determine the number of strokes per minute. Most balers should operate with some seventeen to twenty-eight strokes per minute. All balers should have a tucking device to fold over the tails and allow them to be pressed into the bale by the next stroke of the plunger.

396. Block Setter.—Many balers are now equipped with a special block-setting device so that it is not necessary for the operator to risk his fingers or his hand in placing the block (Fig. 461).

The block is placed in a special container or block setter. When it is desired that a new block be set, a lever brings this container forward, and the feeding device, on its downward stroke, strikes the block on top, shoving it automatically into place. Other balers may have a special retainer which is tripped by pressing a button, thus setting the block automatically.

All feeder heads should be equipped with safety devices to prevent breaking the feeder arms in case the feeder head should catch on an obstruction on its downward stroke. Some have an automatic release clutch; others have large springs to allow the feeder arms to give without breaking.

397. Baler Sizes.—The size of the press is given according to the size of bale made. The more common sizes are 14 by 18 inches, 16 by 18 inches, and 18 by 22 inches. The average length of the bale is around 36 inches.

398. Capacity of a Baler.—In determining the capacity of a hay baler of any kind, it is well to consider such factors as (1) the kind of hay, (2) the condition of the hay, (3) the number of strokes at which the baler runs, (4) the experience and ability of the crew, (5) the density of bales desired, (6) the number of resettings that will have to be made, and (7) the size of the bale. All these things considered collectively will determine to a certain extent the number of bales or tonnage a baler may put out in a day's time.

399. Density of Bales.—The density of the bales is regulated by closing the outlet to such an extent that it will be harder for the compressed hay to be forced out. Naturally, the greater the force required to move the hay out of the baling chamber, the greater the density will be and the more pounds per cubic foot.

400. Three- to Four-man Pickup Hay Baler.—The pickup baler is a regular power hay baler with a pickup and cross-conveyor feeder attachment (Fig. 462). The pickup attachment is a modification of the windrow pickup attachment for combine harvester-threshers. The hay pickup consists of a pickup cylinder, an elevating unit of either

canvas or lugged chains, and a cross-conveyor to receive the hay from the elevator and carry it to the self-feeder. The tight-bottomed elevator prevents the loss of tender leaves.

Power for operating the baler or press and cross-conveyor is furnished either by the tractor power-take-off (Figs. 463 and 464) or by an engine

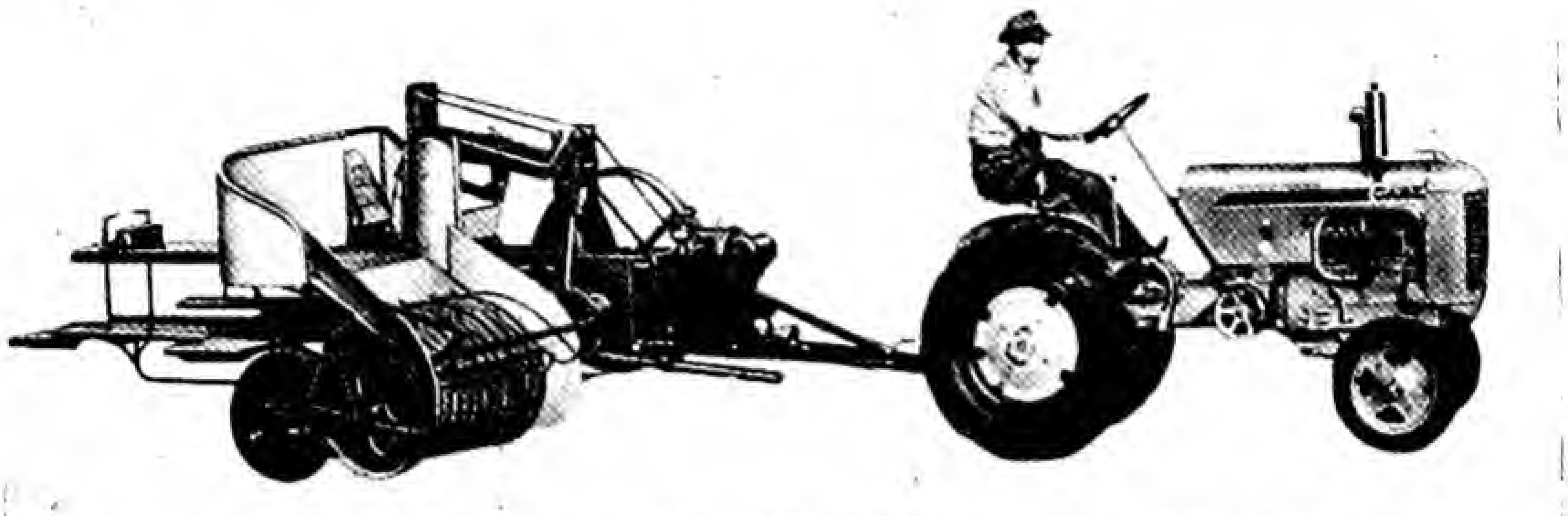


FIG. 462.—Three-man windrow pickup trailer baler operated by gas engine.

mounted on the press (Fig. 462). The pickup and elevating unit is ground-driven so that the hay is gathered in at the same rate of speed as the forward travel of the machine.

The cross-conveyor is operated as a unit with the press, independent of the elevator, and can be started, stopped, or reversed by a lever that can be kicked over with the foot or operated by hand. Thus, the cross-

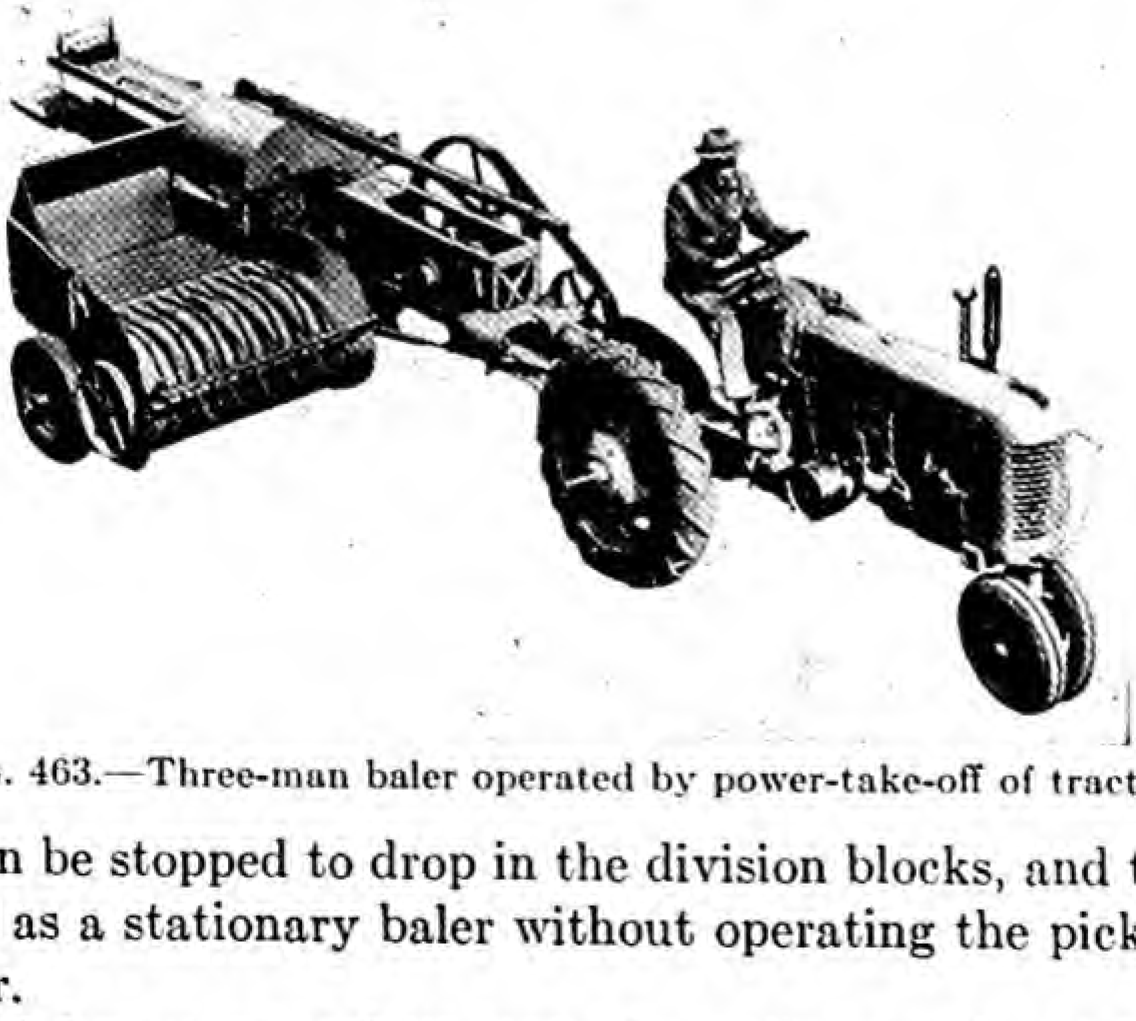


FIG. 463.—Three-man baler operated by power-take-off of tractor.

conveyor can be stopped to drop in the division blocks, and the machine can be used as a stationary baler without operating the pickup cylinder and elevator.

A crew of from two to four men, depending on the yield of hay, is required to operate a pickup baler. One man drives the tractor, two men

tie out the bales, and in heavy hay one man assists the feeding mechanism. A crew of this size can average baling 2 to 3 tons per hour, the tonnage baled fluctuating with the yield. The capacity of the machine largely depends upon two factors, namely, a windrow large enough to furnish hay for capacity operation, and the skill of the operators.[1] Figuring labor, tractor charge, and depreciation, the estimated cost of baling hay with the windrow pickup baler averaged \$3.45 per hour. When baling 1.59 tons per hour the cost per ton was \$2.17, but when 2.75 tons were baled per hour the cost was reduced to \$1.42 per ton.

FIG. 464.—Jeep pulling engine-powered pickup trailer baler.

401. Two-man Pickup Baler.—The two-man pickup hay baler has all the features of the automatic self-tying baler, except that it does not have a knotter to tie the wires. It does have needles and apparatus to place the wires or ties around the bale. A man is required on the baler to do the tying. The machine is called a two-man baler because it requires one man to drive the tractor and one man to tie the ends of the wires together. A 14-horsepower gas engine is required to operate the baler.

402. One-man Automatic-pickup Baler.—This type of baler is an automatic-pickup, self-feeding, and self-tying machine which requires only one man to drive the tractor (Figs. 465*a* to 468). Some makes are operated by a gas engine of about 14 horsepower while others are operated by the power-take-off of the tractor. Most machines put out rectangular bales, but one machine makes round bales (Fig. 468). The size of the rectangular bale varies from 14 by 18 to 16 by 18 inches and from 32 to 42 inches in length. The weight of the bales produced will vary from 40 to 90 pounds, depending upon the kind of hay being baled and its moisture content. The average bale will weigh 60 to 75 pounds. Some makes use a 15-gage wire supplied in rolls, while others use heavy strong twine for tying the bales.

The pickup and feeder may be either on the right or left sides of the

[1] *Iowa Agr. Expt. Sta. Bull.* 322, p. 206, 1934.

machine according to the designer's preference. There are at least four methods of feeding the hay into the press chamber: auger and packer fingers, spring teeth and feeder arms, auger and feeder head, and carrier-roller feed.

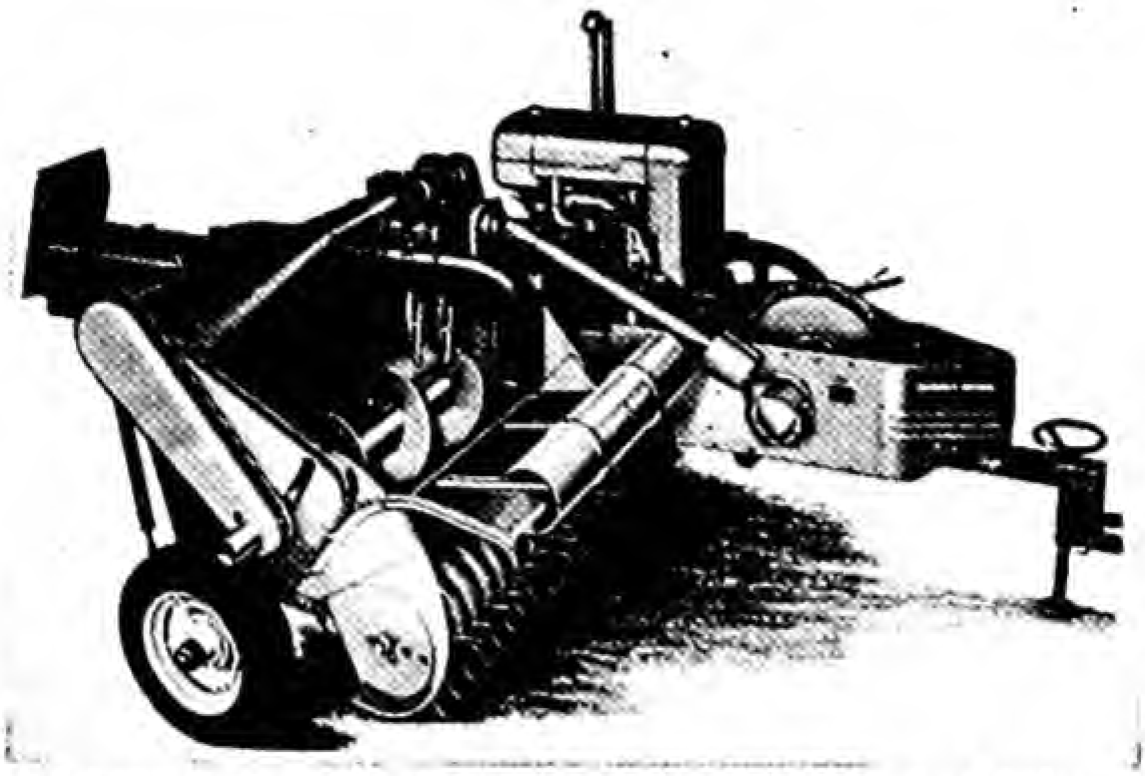


FIG. 465a.—Right-hand automatic-pickup self-tying one-man hay baler. The hay is fed into the bale chamber at the side.

Figure 465*a* shows a pickup cylinder that delivers the hay direct to a floating feed cross auger from which it passes to packer fingers, which feed it into the bale chamber.

In operating the machine shown in Fig. 466, the pickup cylinder passes the hay to a set of spring teeth which in turn pass it to the feeding arms, which feed the hay into the bale chamber. The conventional cross-conveyor is not used. The bales are ejected from the chute to the left of the machine in a turned position so they will be easy for a bale loader to pick up.

FIG. 465b.—The hay baler in operation and with trailer attached for hauling the bales of hay.

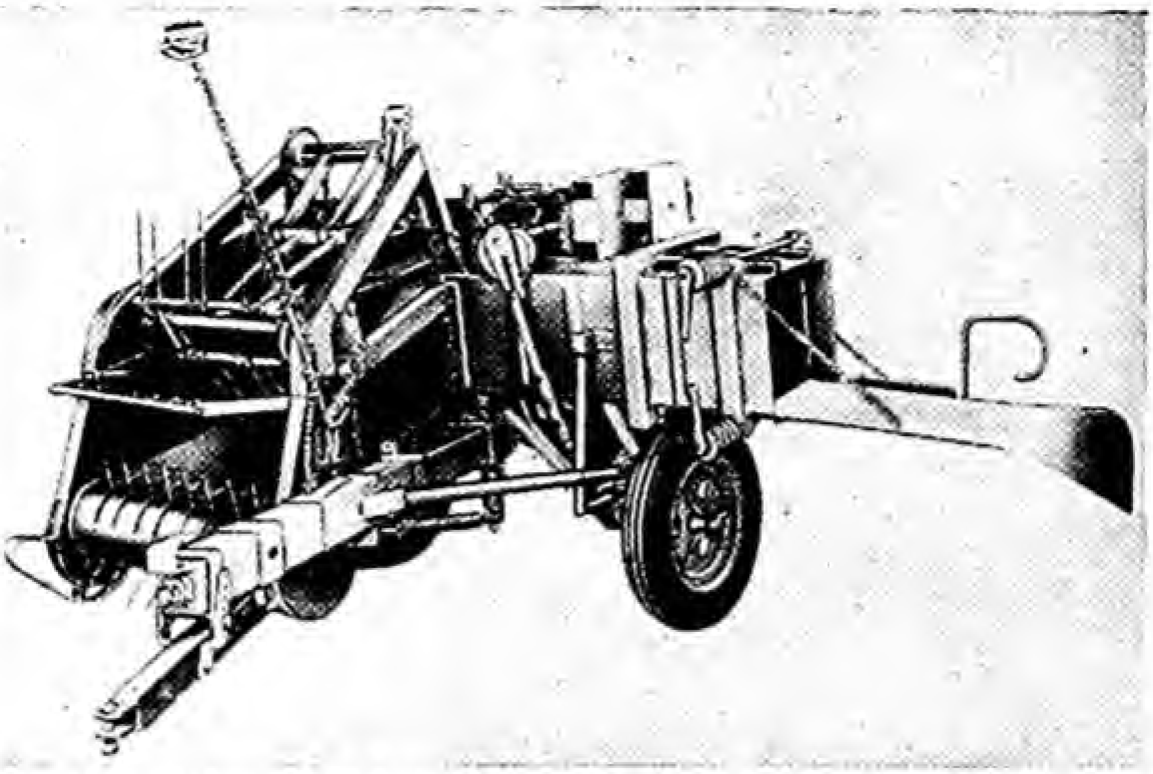


FIG. 466.—Automatic-pickup self-tying one-man hay baler that discharges the bales to the side. As the hay is picked up it is fed directly into the bale chamber.

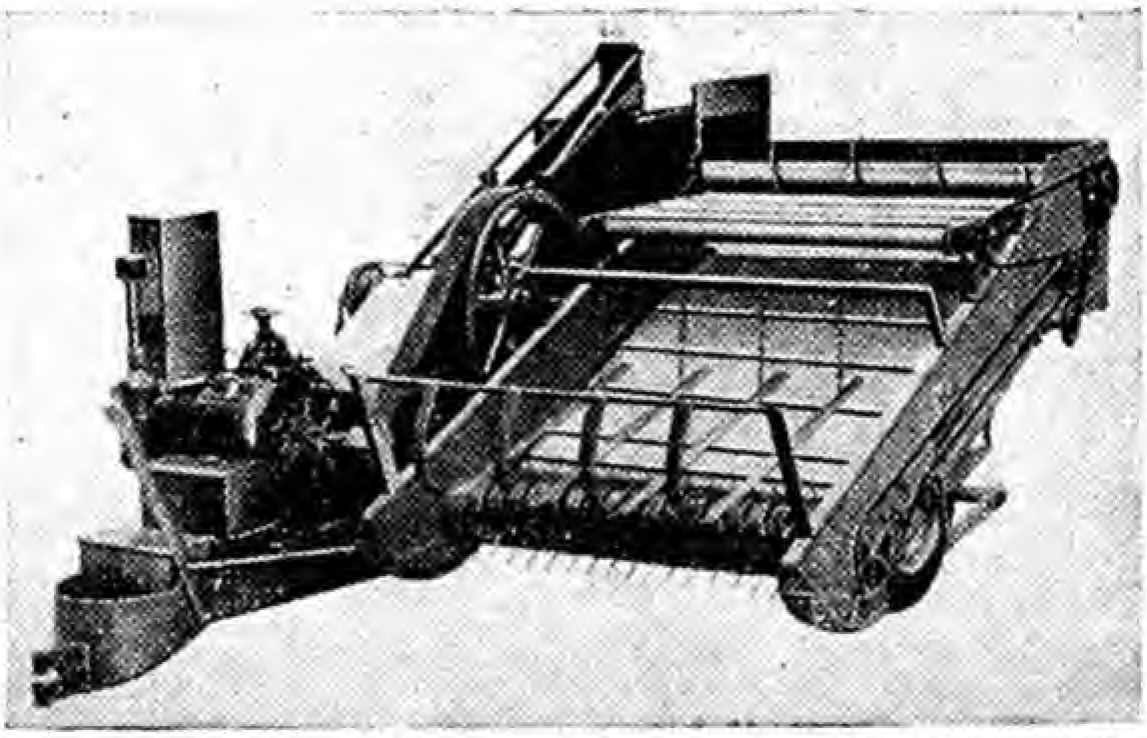


FIG. 467.—Left-hand automatic-pickup self-tying one-man hay baler. The hay is elevated and dropped into the bale chamber.

FIG. 468.—Automatic-pickup hay baler that makes round bales. The bales are spirally wrapped with heavy binder twine.

The machine shown in Fig. 467 picks up the hay and delivers it onto an elevator canvas, which delivers the hay to a cross auger which feeds it into the feed chamber where the feeder head forces it into the bale chamber.

A fourth method of feeding the hay into the bale chamber is shown in Fig. 468. The hay is picked up and delivered onto a carrier which conveys the hay up in a continuous stream into the roll box where it is rolled into a round bale (Fig. 468).

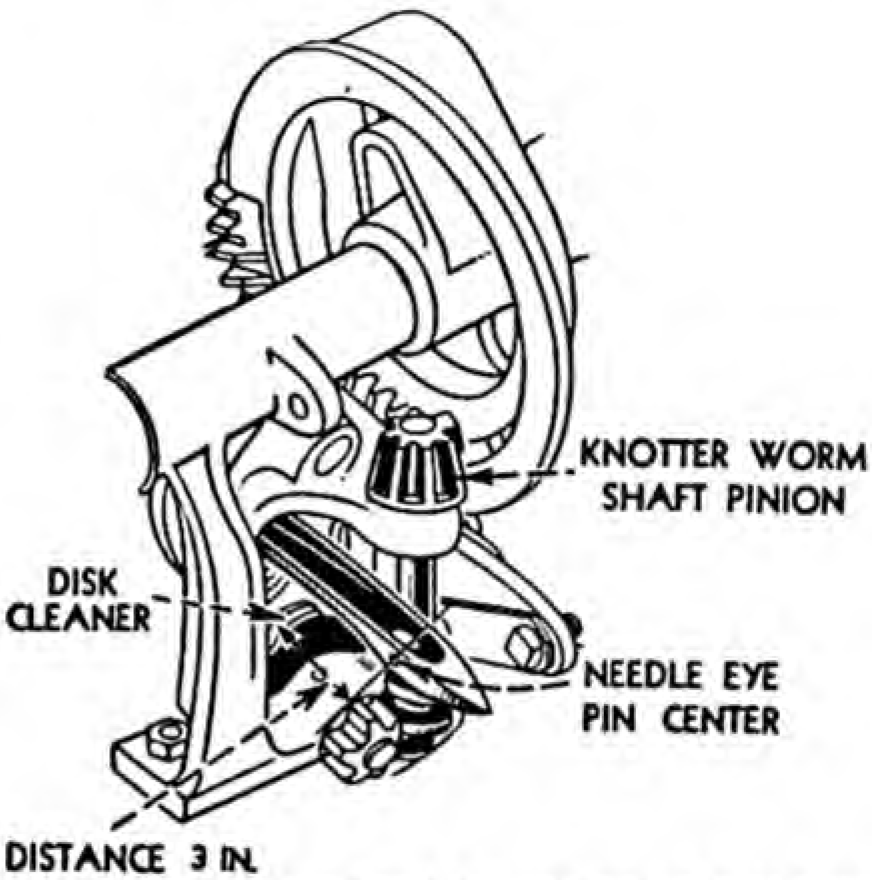


FIG. 469.—Knotter head for self-tying hay baler.

403. Tying Mechanism.—The operating principle of the self-tying hay baler tying mechanism is similar to that on the tractor grain binder (Fig. 469). There are, however, two knotter heads on hay balers, one to tie each of the wires or twine around the bale (Fig. 470). There are of course, two needles. No divider blocks are needed to separate the bales on the self-tying balers. The needles enter the bale chamber protected by the plunger head, and there is no contact by the needles with the hay being baled. Slicing knives on the side of the plunger and on the side of the bale chamber slice the hay each time the plunger advances. The size of the bale is regulated by a metering or measuring wheel which is in contact with the compressed hay in the bale chamber. When the bale in the chamber reaches the proper length, the notched metering wheel trips the clutch to cause the needles to start the tying cycle.

404. Bale Loaders.—Several types of bale loaders are now available whereby the bales of hay are automatically picked off the ground and elevated by an endless carrier chain to a height where a man on a wagon or truck can take the bales and stack them on the truck (Fig. 471).

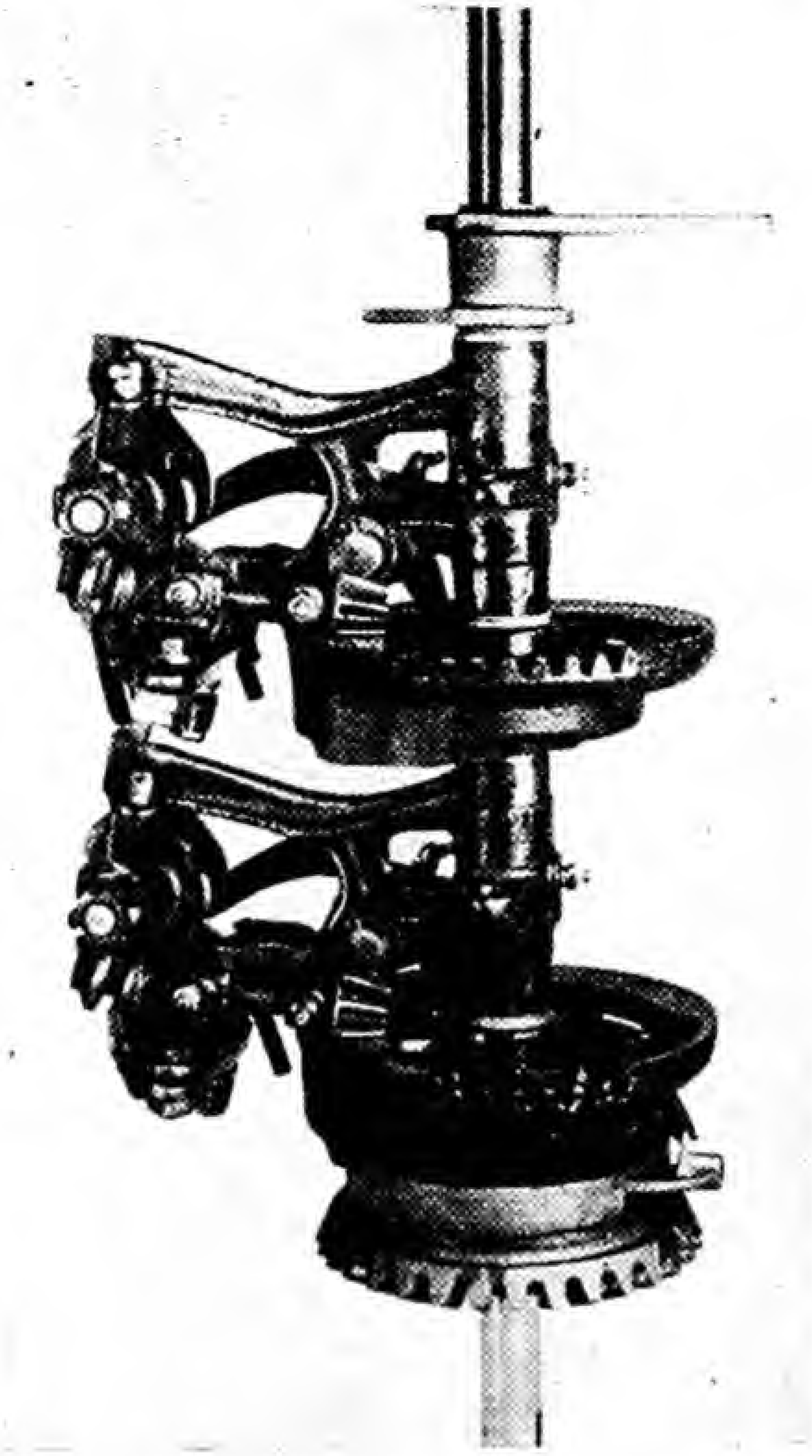


FIG. 470.—Two knotter heads are required on hay balers, one for each of the two ties placed around the bale of hay.

FIG. 471.—Bale loader that attaches to the side of wagon or truck.

BARN EQUIPMENT

Where loose hay is stored in barns, special equipment for handling it is of great help. There should be a track suspended at the peak of the roof as near the rafters as possible. A carrier truck runs along this track to allow the hay to be carried to any part through the center of

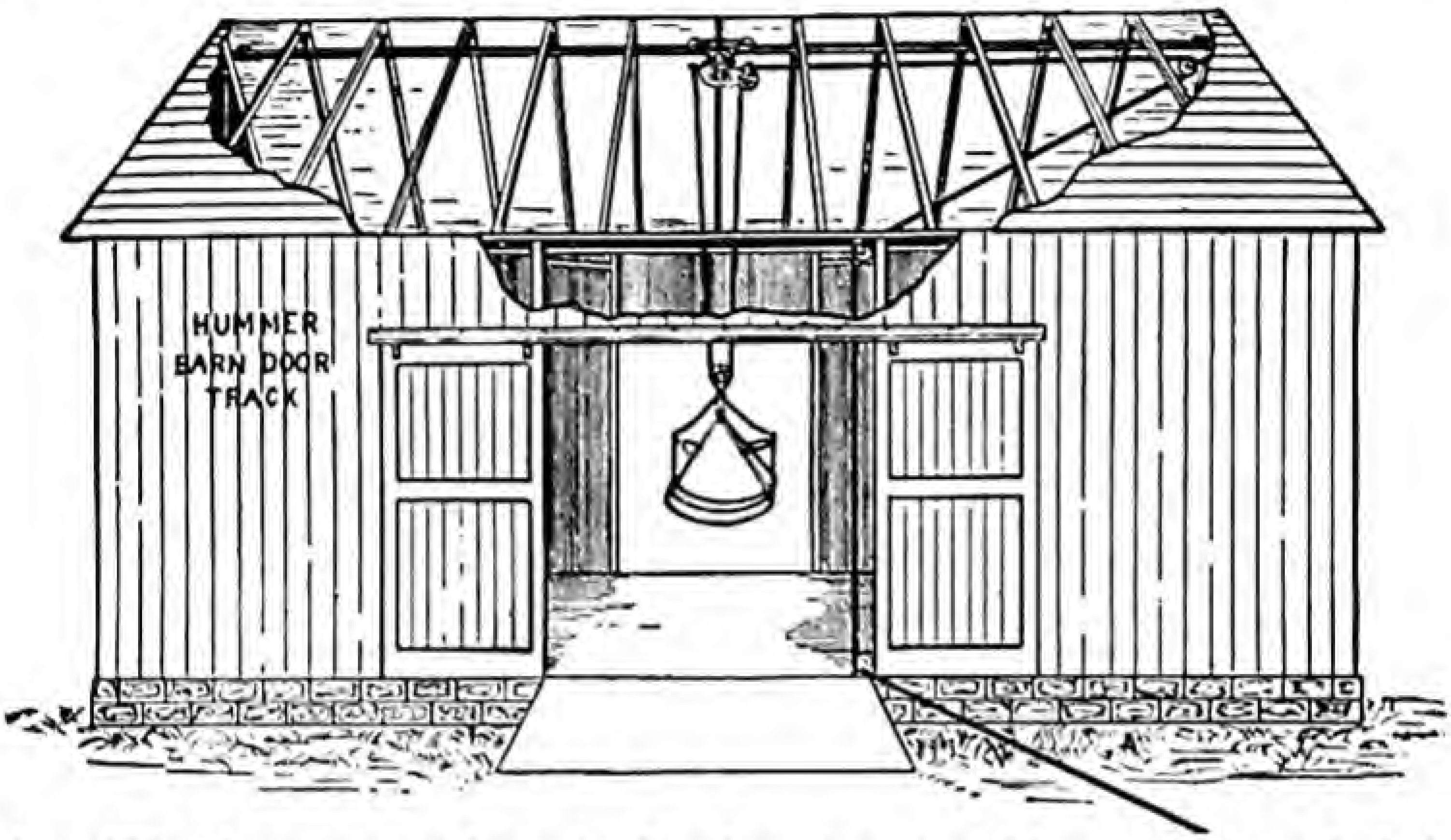


FIG. 472.—Arrangement for unloading hay at center of barn with grapple fork

the barn. Figure 472 shows an arrangement for unloading hay at the middle of the barn while Fig. 473 shows an arrangement for taking the hay in at one end. The hay is elevated by a system of ropes and pulleys. Usually a team of horses furnishes the power for lifting the load.

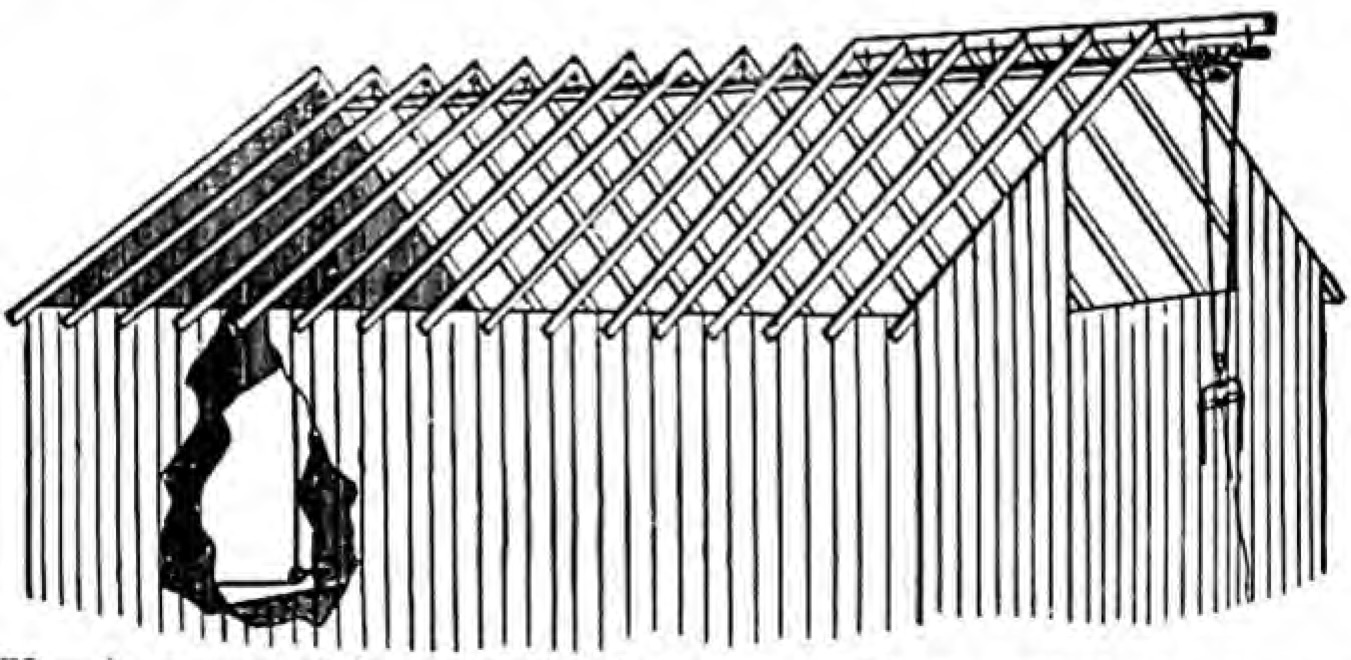


FIG. 473.—Arrangement for unloading hay at end of barn with double-harpoon fork.

405. Hayforks.—The types of hayforks and slings for unloading hay from the wagon to place it on the stack or in the barn differ in the manner in which they take hold of the hay. There are three kinds of forks in general use, namely, the single-harpoon, the double-harpoon, and the grapple fork.

The *single-harpoon* fork (Fig. 474) consists of a single long iron fork with a barb on the end, which, when the bar is being forced into the hay, forms part of the point, making it easier to force the fork down. When it has been forced to the required depth, a lever arrangement pulls this barb to the side, causing a considerable amount of hay to cling to the fork which can be elevated to the stack or carried inside the barn.

Double-harpoon forks, instead of having one spear-like prong, have two prongs placed some two feet apart (Fig. 475). This type of fork is more popular than the single harpoon because it will retain more hay.

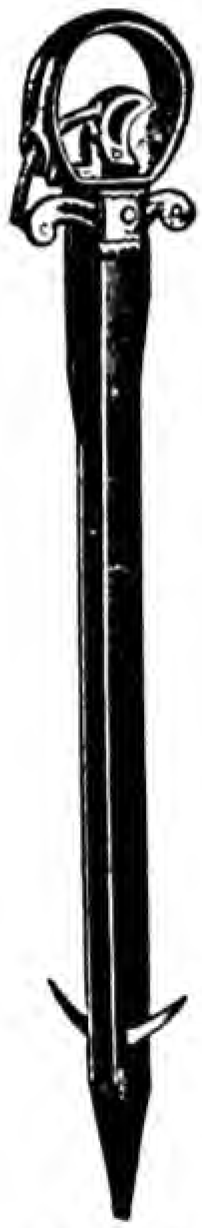


Fig. 474. —Single-harpoon fork.

Fig. 475.—Double-harpoon fork.

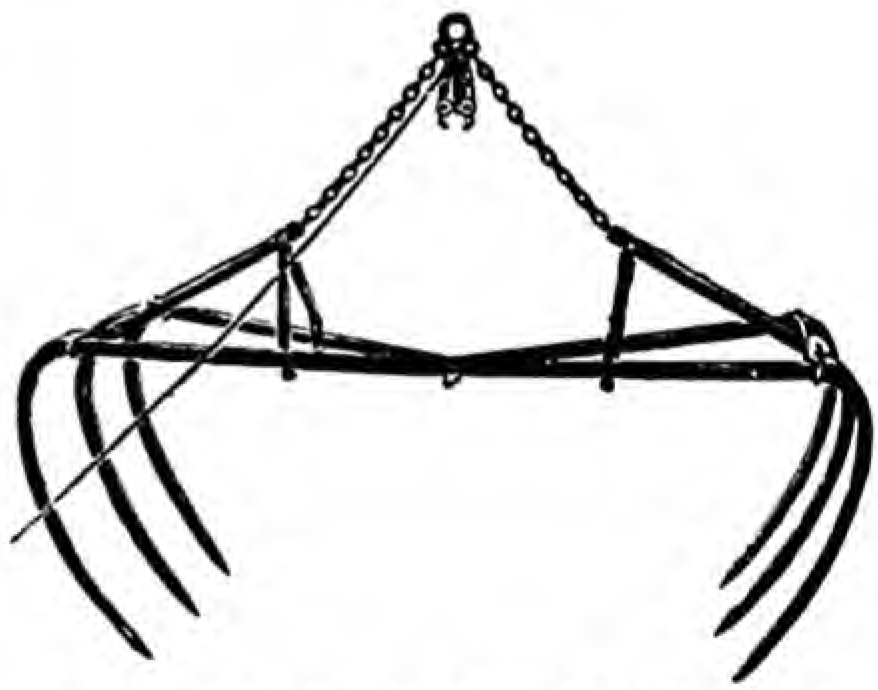


Fig. 476.—Six-tine grapple fork, open.

The *grapple* fork (Fig. 476) resembles, in a general way, a pair of ice tongs. There are two or three teeth to each side which open out when forced into the hay. As power is applied to the central point, they act like jaws, clamping a considerable amount of hay in the teeth. This is a very useful type in unloading loose straw.

Another device for taking the hay from the wagon is the *sling* (Fig. 477). In loading the hay on the wagon rack, the first sling is placed on the bottom, a quantity of hay placed on it, as much as can be elevated at one time, then another sling is placed on top of this

hay, and so on until the wagon is completely loaded. Then, at the barn the ends of these slings are brought together and elevated into the barn or on the stack. When the hay is ready to be dropped, the sling is tripped in the middle, allowing the ends to swing free.

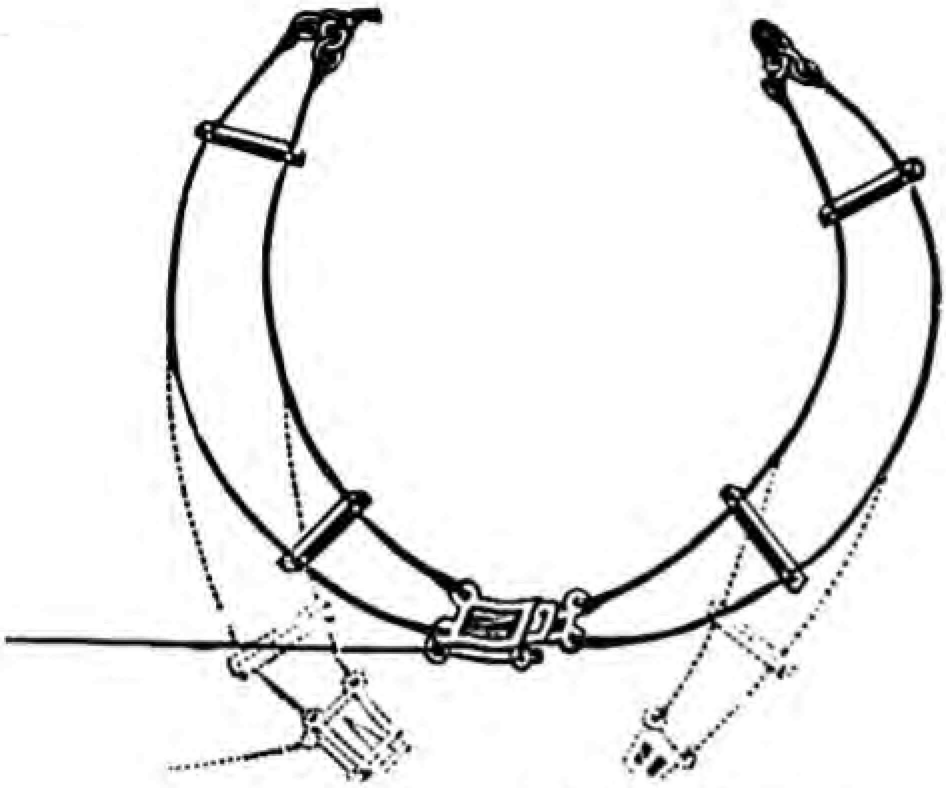


FIG. 477.—Center-trip hay sling.

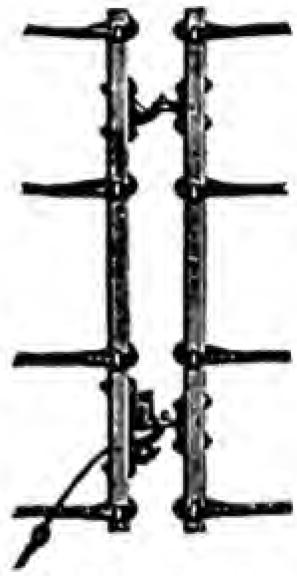


FIG. 478.—Double lock for hay sling.

FARM HAY DRIERS

The curing of high-quality hay on the farm to retain its maximum content of feeding value, including minerals and vitamins, is very important. Under normal field-curing methods there is always a loss in the nutritional value of hay, which often may be as high as 30 to 40 per cent, depending upon weather conditions. In fact, the entire crop may be lost. There are two main sources of loss in field- or sun-cured hay. The first is loss of the leaf, the most valuable part of the plant. The second is weathering. The stems do not dry as fast as the leaves; therefore, the crop must be left in the field longer than necessary for the leaves to cure sufficiently for safe storage. When this is done hay is often subjected to rains and dews followed by hot sunshine. These losses can be largely avoided by the use of a low-cost hay drier or hay finisher.

406. The Farm Hay Drier or Finisher.—The hay drier or finisher consists of a system of air ducts on the floor of the hay mow or barn on which the hay is placed to a depth of 6 to 10 feet, depending upon the moisture content of the hay. Air is forced through the air ducts and up through the hay by a centrifugal or propeller-type fan driven with an electric motor. With this system, the hay is allowed to cure partially in the field to a moisture content of 45 to 50 per cent before it is placed on the drier. Unheated air forced through the system will ordinarily dry the hay to 20 per cent in 7 to 14 days, depending upon the outside atmospheric conditions. Alfalfa hay will usually dry in the

swath to 50 per cent within 3 to 4 hours after it is cut; therefore, it is possible to get the hay into the barn on the same day that it is cut.

The farm hay finisher is a simple arrangement of header and lateral air ducts on the mow floor. There are several methods of arranging the duct systems, which may be classified as follows: (1) Single-side-main, (2) single-center-main, (3) divided-center-main, and (4) the slatted-floor system. In most installations the main header duct is built above the floor, but successful systems have been constructed with the header duct below the floor level. Laterals may be constructed of either wood or

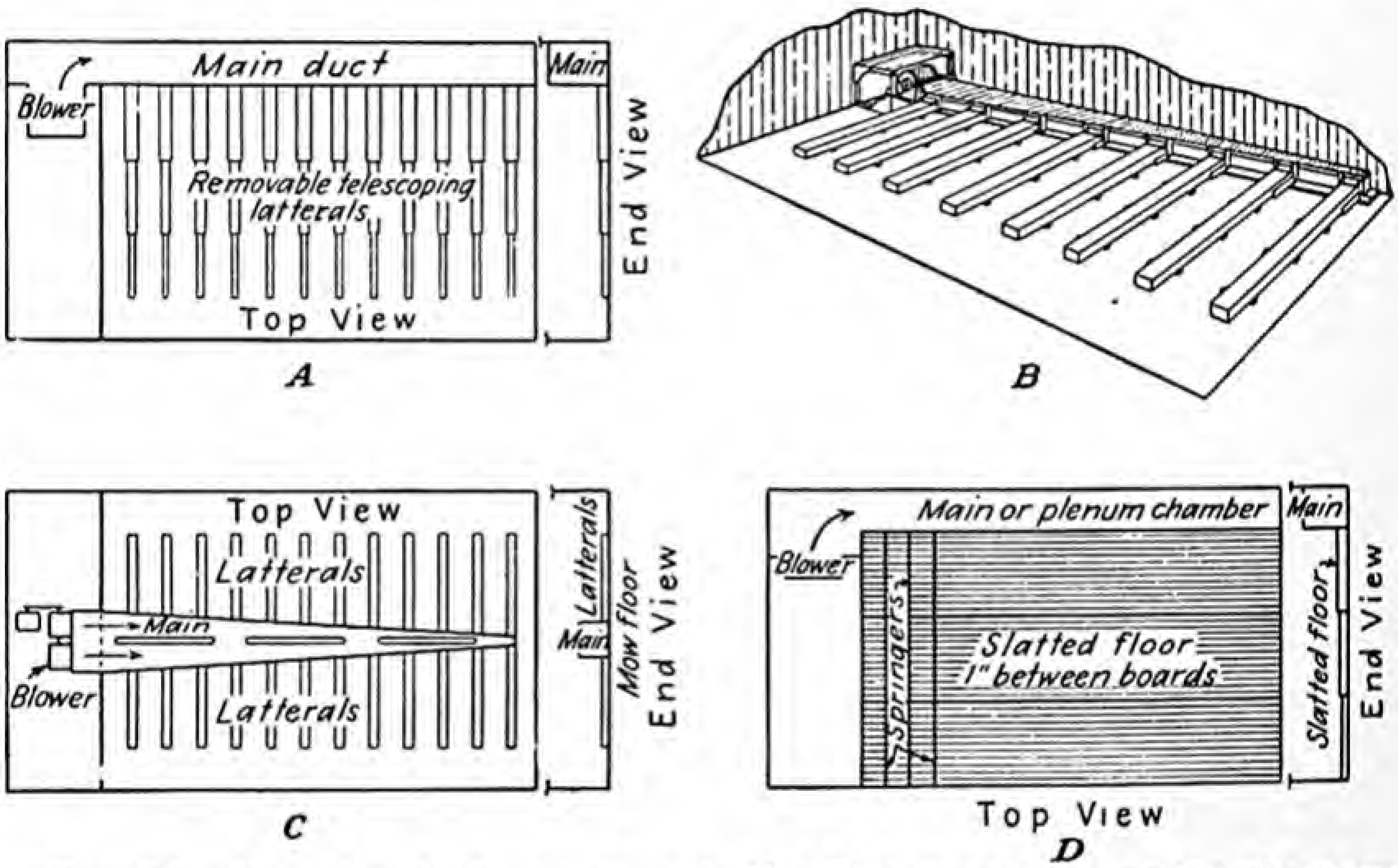


FIG. 479.—Farm hay-finisher systems: *A*, The Ohio main duct and lateral system; *B*, The tapered single-side-main-duct system; *C*, the single-center-main-duct system; *D*, The slatted-floor system.

1-inch heavy-mesh wire. Where high-velocity air is used the main header duct is tapered with a large cross section at the fan and a small cross section at the opposite end. The Ohio Experiment Station uses a large main duct of uniform size with a low air velocity.

407. The Single-side-main-duct System.—This system consists of a main air duct placed along one side of the barn, with radial laterals spaced 2 to 4 feet on centers extending out over the mow floor (*A* and *B* Fig. 479). This system is suited to barns less than 30 feet in width and not over 70 feet in length.

The fan is placed at the large end of the main duct, either inside or outside the barn. It should be installed so that fresh clean air is drawn from outside the barn. If heated air is used the fan should be outside. The fan should discharge directly into the main header duct.

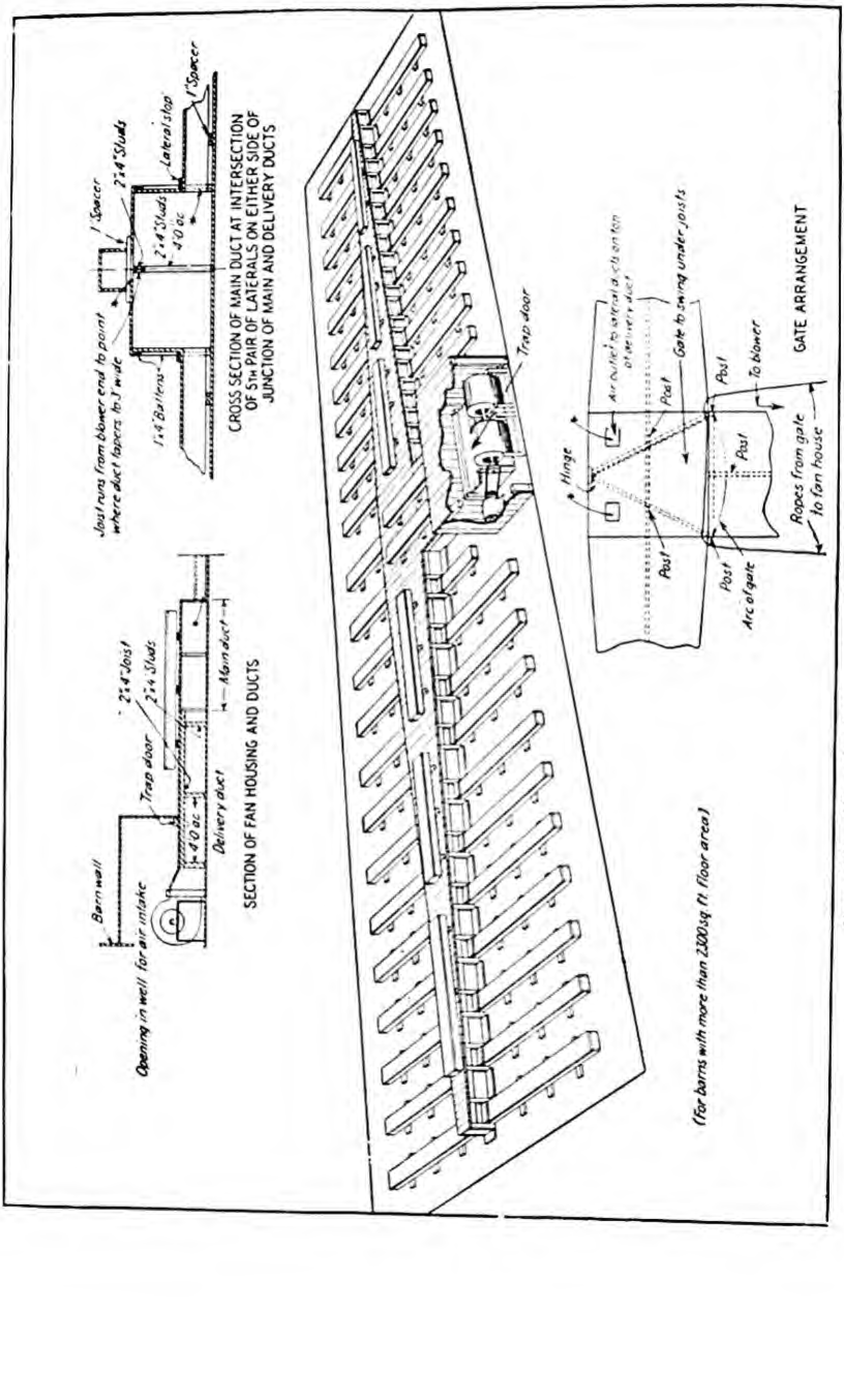


FIG. 480.—The divided-center-main-duct hay-finisher system.

408. The Single-center-main-duct System.—The system shown in *C* Fig. 479 is a typical single-center-main-duct system. It is sometimes called a *double system.* The main duct is placed in the center of the barn. Laterals extend out from each side of the main duct. The fan discharges directly into the main header duct.

409. The Divided-center-main-duct System.—In this system the main duct is located on the center line of the long axis of the barn. The fan is placed on one side and discharges air through a short delivery duct to the center of the main header duct (Fig. 480). When the main header duct is built in a long barn which requires many laterals, gates or valves at the junction of the delivery duct and the main duct enable air to be blown alternately into either end of the system by swinging the valve into the proper position (Fig. 480).

410. The Slatted-floor System.—The slatted-floor system is similar in many respects to the single-side and center-main-duct systems except a slatted floor is substituted for the laterals (Fig. 479*D*). The slatted false floor is constructed on stringers several inches above the mow floor, thus making a plenum-like chamber between the two floors.

411. Design of the Main Duct and Laterals.—The basic factor in the design of the air distribution system is to provide uniform air movement throughout the mass of hay or grain. The system consists of one or more airtight headers which distribute the air to small laterals extending out at regular intervals from the side of the headers. The bottom of each lateral is open. The laterals are raised approximately 1 inch from the floor by means of 1 by 2 inch spacers placed at approximately 3-foot intervals. The air passes out through the openings along the bottom edges of the lateral and up through the hay or grain.

The arrangement of the main header, or headers, is determined by the size and shape of the barn floor or grain bin. If the width of the barn is 28 feet or less, the main header is usually located along one side. If the barn is 28 to 40 feet wide, the main header should be placed in the center. In barns up to 75 feet in length, the fan is placed at one end. If the barn is 75 to 150 feet in length, the fan is placed at the center of the barn and provision made to direct the air through either end of the system. Barns larger than 40 by 150 feet require more than one air distribution system.

The main header is tapered to provide uniform distribution of air to all laterals. The header is usually designed to provide an air velocity of approximately 1,600 cubic feet per minute. Therefore, the total cross-section area of the main header at the intake may be calculated by the following formula:

$$\left.\begin{array}{l}\text{Cross-section area at intake}\\ \text{of header (square feet)}\end{array}\right\} = \frac{\text{volume of air (cubic feet per minute)}}{1{,}600}.$$

Thus, if the fan delivers 10,000 cubic feet of air per minute, the cross-section area at the intake of the header would be 10,000 divided by 1,600, or 6.25 square feet. Multiplying this figure, 6.25, by 144 gives 900, the cross-section area of the header in inches.

For ease in installation, the header at the intake is usually made the same width as the fan outlet. The height of the header can then be calculated by dividing the total cross-section area in square inches by the width in inches. If the width of the fan outlet is 24 inches, the height would be calculated as follows:

$$\text{H (in inches)} = 900/24 = 37\tfrac{1}{2}.$$

The height of the header is usually the same throughout its length with all the taper being in the width. The width of the header at the outer or small end may be determined by dividing the cross-section area of one lateral by the height of the header. Again, for ease in construction, this width is never made less than 4 to 6 inches.

412. Types of Fans.—The *centrifugal*, or *multivane*, type of fan (Fig. 481) is designed to deliver large volumes of air against relatively low static pressures. They are made in both "forward-curve" and "back-curve" types, depending upon the shape of the impellers, or blades. The forward-curve fans operate at relatively low speeds but vary widely in volume of air delivered and power required against varying static pressures.[1] The back-curve fans operate at approximately twice the speed of the forward curve but give a more uniform air delivery and power demand against widely varying static pressures.

Centrifugal fans are made in both single- and double-inlet types, depending upon whether the air enters one or both sides of the fan housing.

Most fan manufacturers have developed lightweight, light-duty centrifugal fans in sizes up to 24 to 30 inches (size refers to diameter of rotor or fan blades), especially designed for use in air-conditioning systems where static pressures rarely exceed 1½- to 2-inch water column. These are available in either single- or double-inlet types. In some cases, two or more fan units are mounted on a single shaft for increased capacity.

The heavy-duty, centrifugal fans are made in both forward- and

[1] Static pressure is the force exerted by the fan in forcing air through a duct system. It is usually expressed in "inches-water column," or the distance the pressure will depress a free column of water in a U-tube.

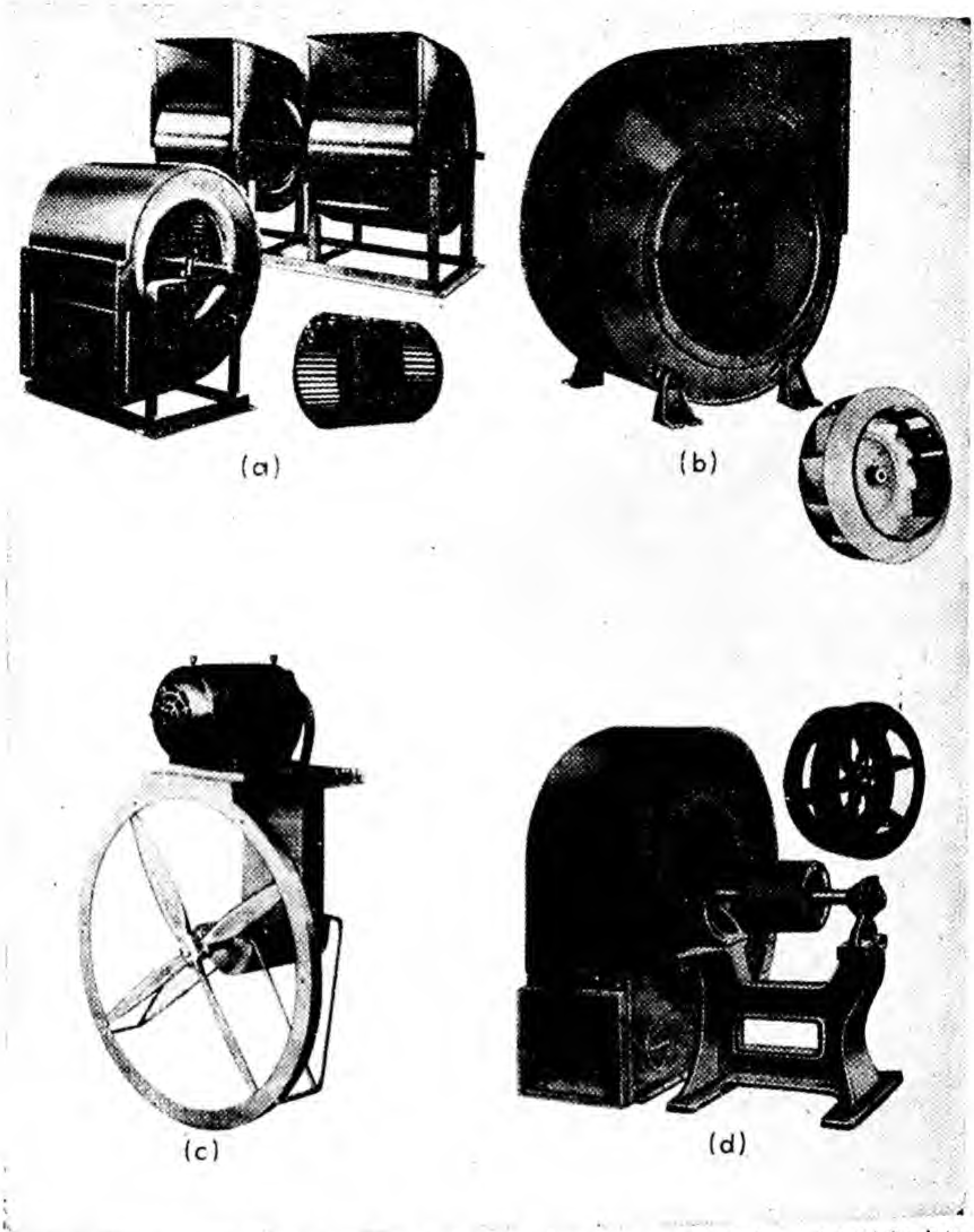


FIG. 481.—Types of blowers best suited for hay and grain drying. (*a*) Light-duty single-and double-unit double-inlet multivane fans. Slow speed, large volume, low pressure. For 1- to $7\frac{1}{2}$-horsepower motor. (*b*) Heavy-duty single-inlet back-curve multivane fan. Medium speed, low and medium pressure, large volume. For 1- to $7\frac{1}{2}$-horsepower motor. (*c*) Propeller-type fan designed to operate against pressure. High speed, low pressure, large volume. For 1- to $7\frac{1}{2}$-horsepower motor. (*d*) Exhauster or cotton-gin fan. High speed, high pressure, medium volume. Not suitable for operation with 1- to $7\frac{1}{2}$-horsepower motor.

backward-curve types and in a wide range of sizes from about 12 inches up to 180 inches or more. The heavy-duty fans are ordinarily used when the amount of air required exceeds the capacity of the larger sized light-duty fans.

Propeller-type fans are designed to deliver large volumes of air against relatively low static pressures (Fig. 481). They operate at relatively high speeds and are somewhat noisy. Most propeller fans are designed for operation against static pressures of $^3/_4$ inch water column, or less, although some special types will operate against pressures of 3 inches or more. The ordinary "attic-ventilator" type propeller fan designed to exhaust into open air is not satisfactory for use with hay or grain driers. The introduction of heat into the air stream of a drying system using a propeller-type fan is somewhat more complicated than with the centrifugal-type fans.

CHAPTER XXI

GRAIN-HARVESTING MACHINERY

Grain binders are generally considered complicated machines by the inexperienced. This is largely because they embody parts that perform different operations, such as transmission of power, cutting, conveying, elevating, and binding, all of which must work together in perfect timing. Grain binders may be classified as *horse-drawn* and *tractor*.

413. Driving Mechanism.—The horse-drawn binder receives its power for operation from the ground-traction bull wheel (Fig. 482),

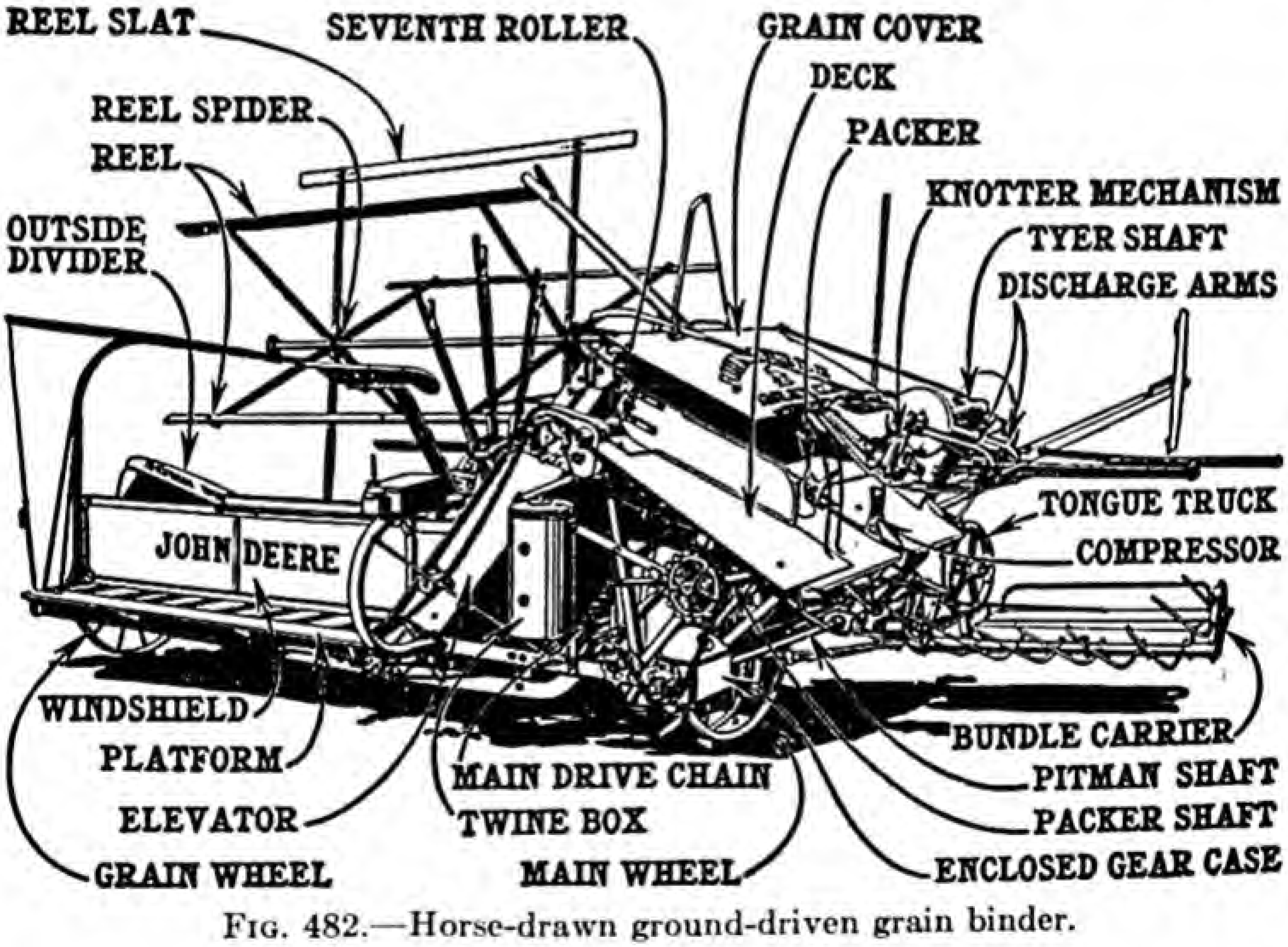


FIG. 482.—Horse-drawn ground-driven grain binder.

while tractor binders are operated by power from the tractor through the power-take-off (Fig. 483). Where traction is poor, as in wet rice fields, binders may be equipped with auxiliary engines.

In each of the three power sources the power is connected directly or indirectly to the rear end of the crankshaft. From the crank or pitman shaft, power is transmitted to the various functioning parts of the binder by chains, sprockets, and gears (Fig. 484). Slip or snap clutches are provided for safety.

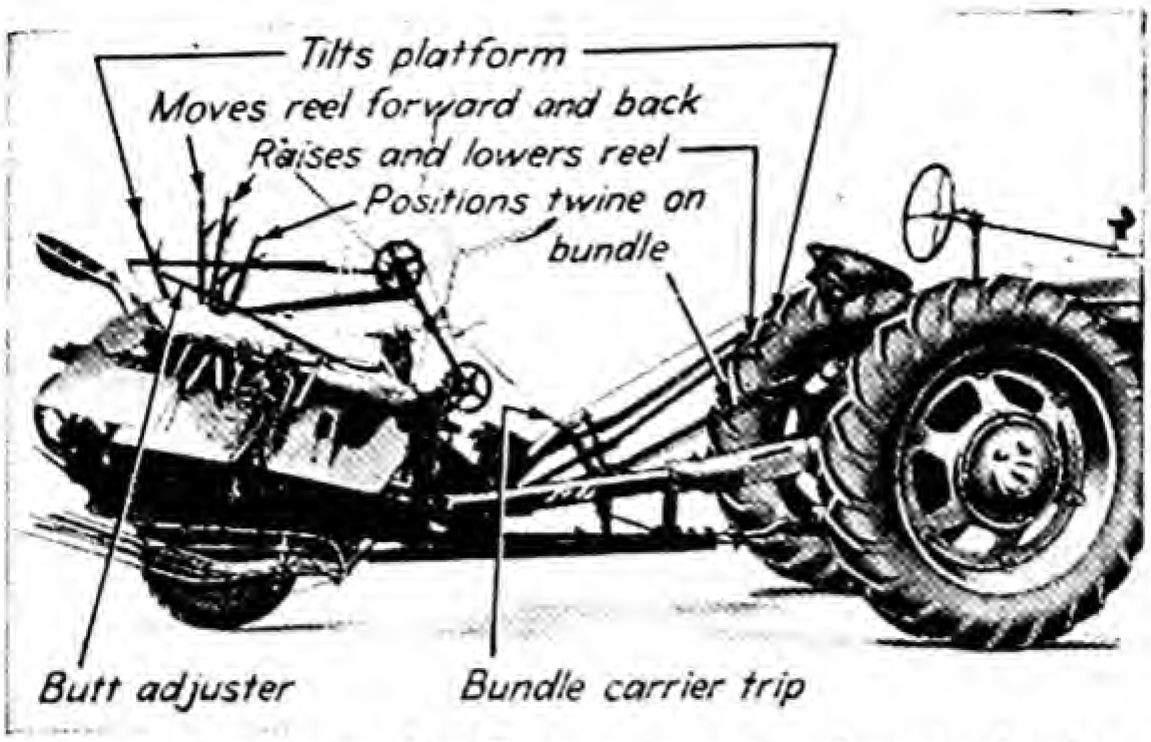


FIG. 483.—Side view of power-take-off tractor-operated grain binder, showing hitch, power-take-off, and position and function of various levers.

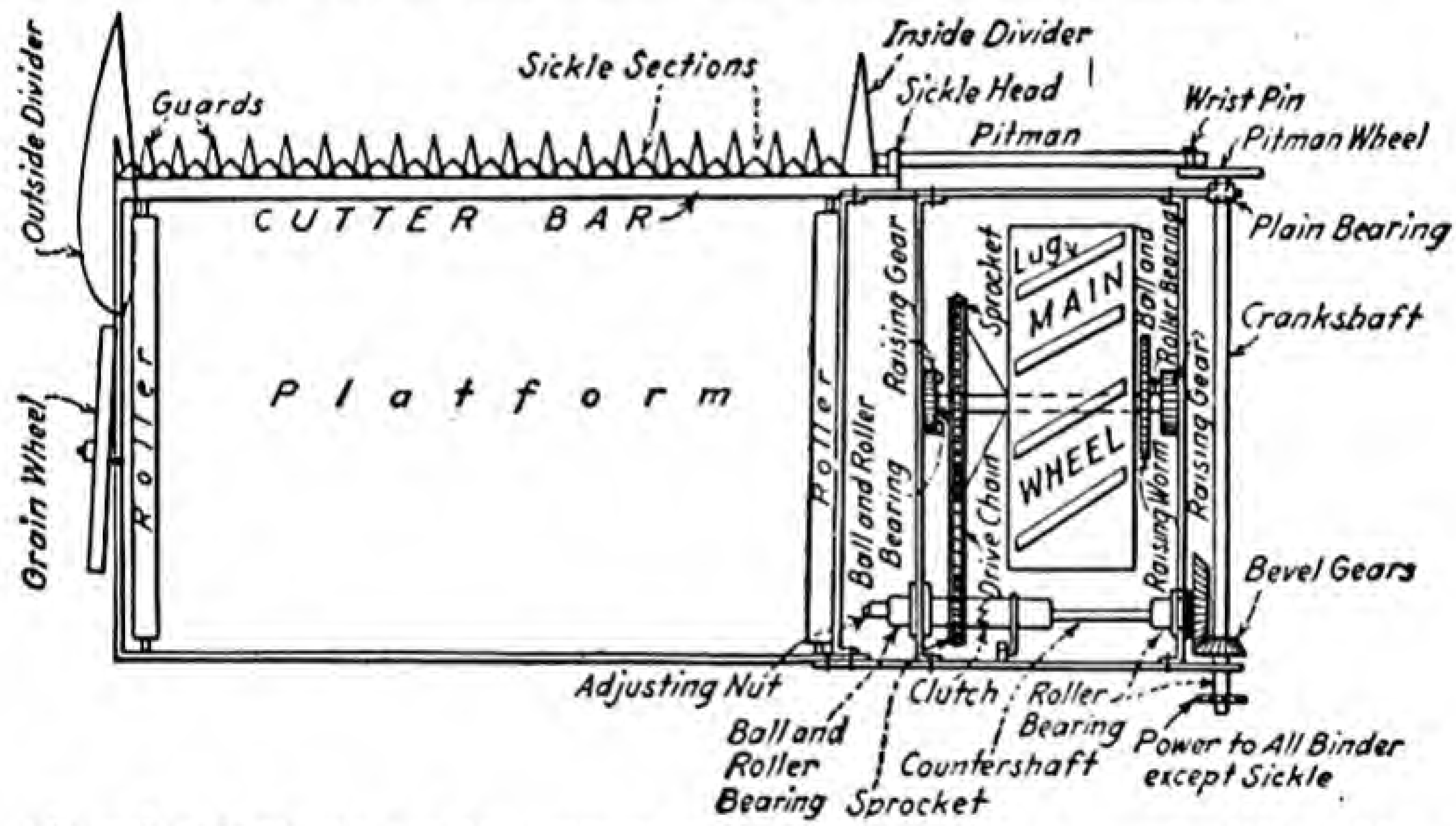


FIG. 484.—Overhead view of the transmission of power from main wheel to sickle, with frame and platform.

414. Cutting Mechanism.—The sickle is driven from the front end of the crankshaft. The sickle for grain binders compares very closely with the knives for mowing machines, the principal difference being that the sections of the sickle are smaller and serrated along the edges. The sickle, instead of passing from the center of one guard to the center of the other, passes from the center of one guard directly through the next and on to the center of the third. The travel is twice the distance of that of the mowing-machine knife, and the speed, of course, is about one-half as great. Since the binder is cutting only the stems of small grains, not so much power and speed are required as in the mowing machine, which must cut hard grass stems closely matted together.

The guards for the sickle are smaller than those on the mowers. As the sickle sections are serrated the ledger plates on the guards are

smooth. The reel slats should strike the heads of the grain 3 to 6 inches below the heads and should contact the grain slightly before the stems are severed by the sickle so the grain will be thrown back on the platform canvas. The reel is adjustable both vertically and horizontally.

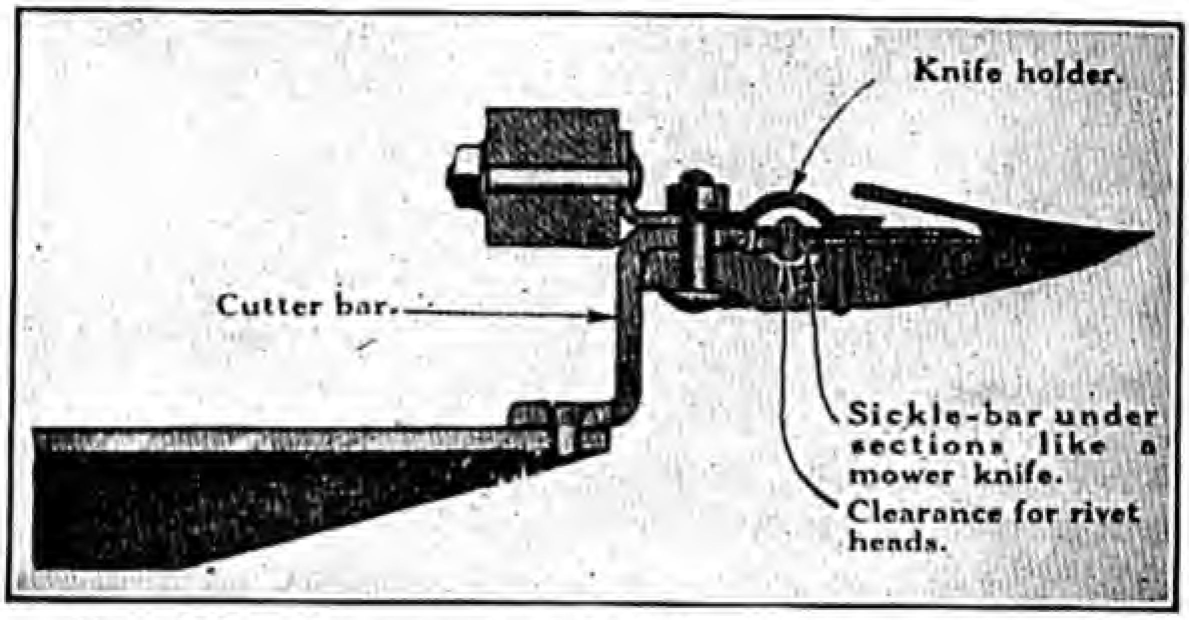


FIG. 485.—Cross section of binder cutting mechanism.

415. Conveying and Elevating Mechanism.—This mechanism consists of the platform canvas for conveying the grain to the elevator canvases (Fig. 486). The grain is elevated between the upper and lower elevator canvas. Between the upper end of the lower elevator canvas

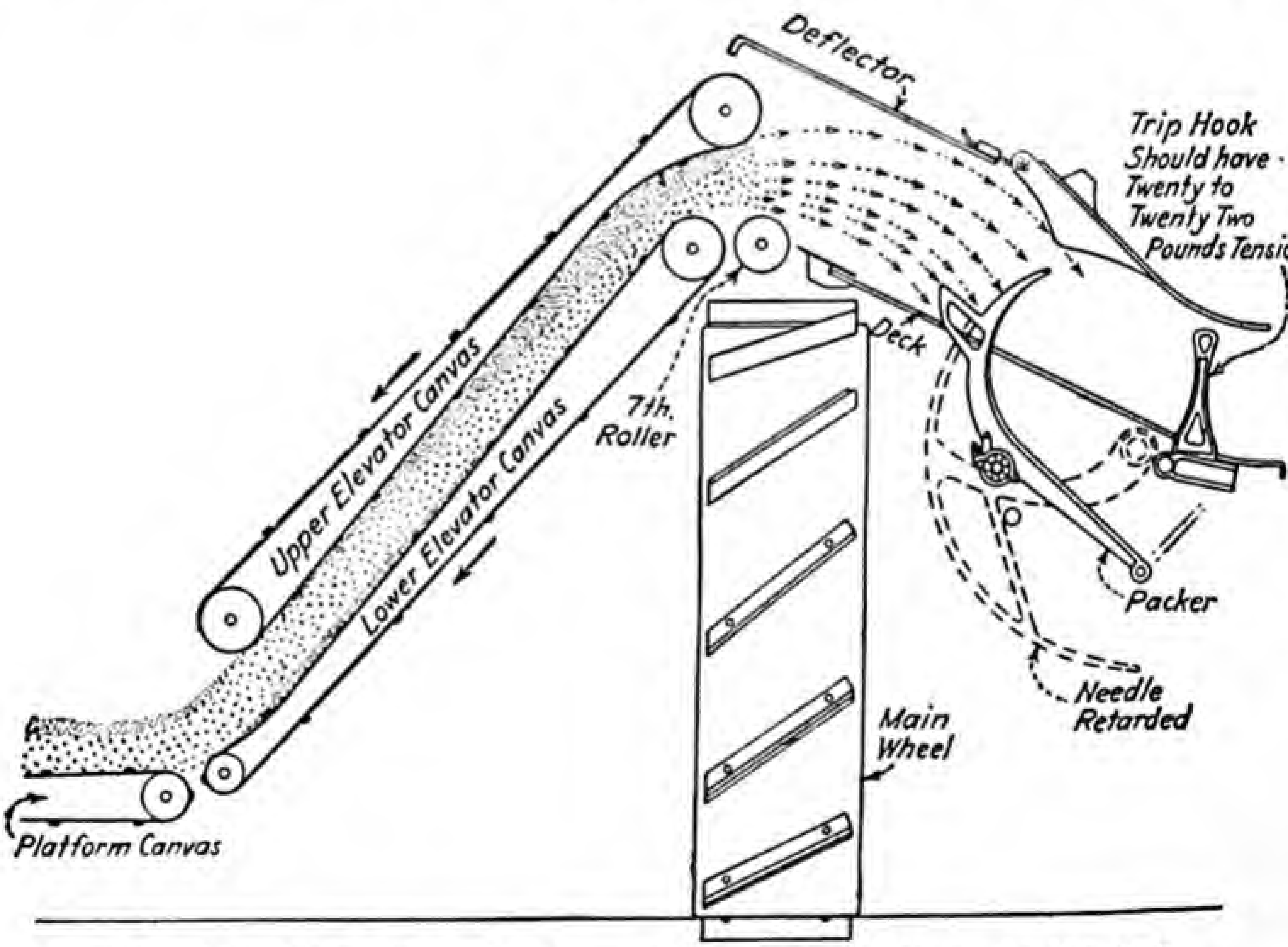


FIG. 486.—How the grain is carried from the platform to the deck.

and the binder deck is an extra free-turning roller called the *seventh roller*, which acts as a stripper roller for the lower elevator canvas or, in other words, prevents the grain from following the canvas and aids in conveying the grain over onto the binder deck. The grain slides down the

sloping deck to where it is caught by the packer arms, which pack the grain against the trip arm. Pressure of the packed grain causes the trip arm, which is under spring pressure, to move and trip a clutch which engages and operates the tying mechanism (Fig. 486).

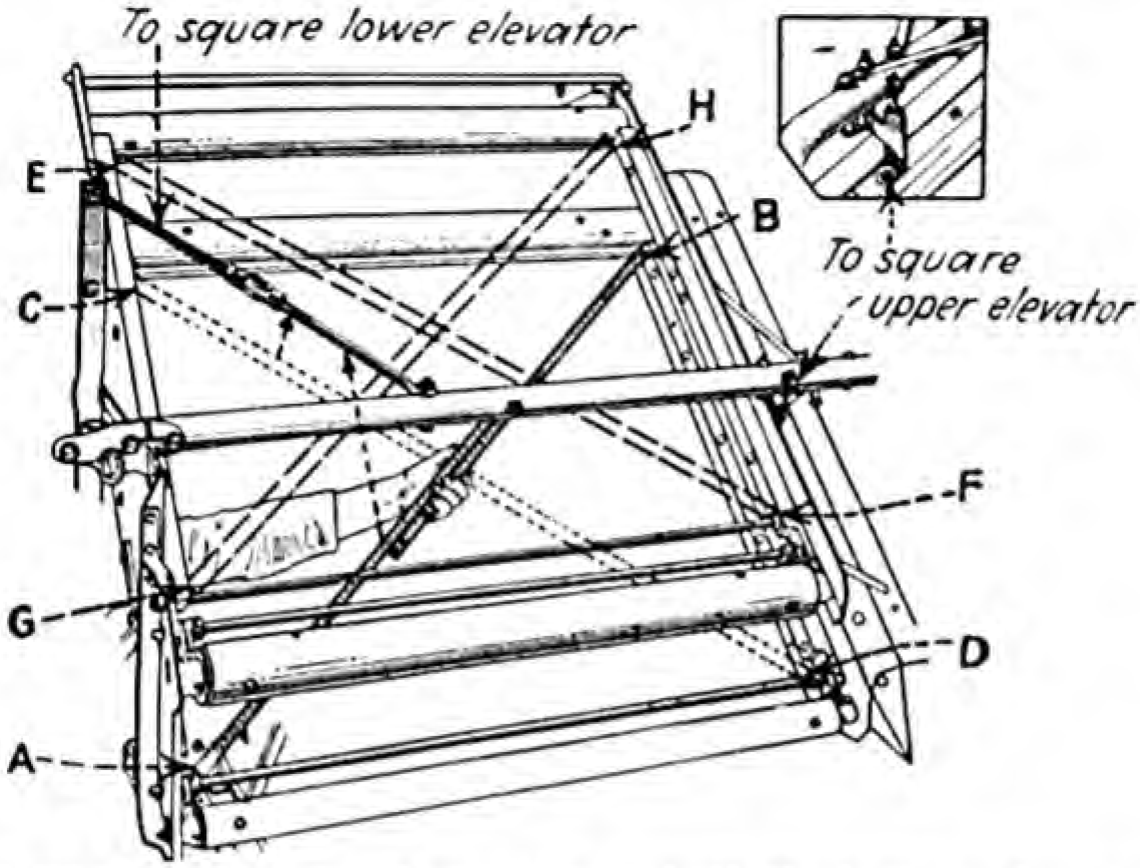
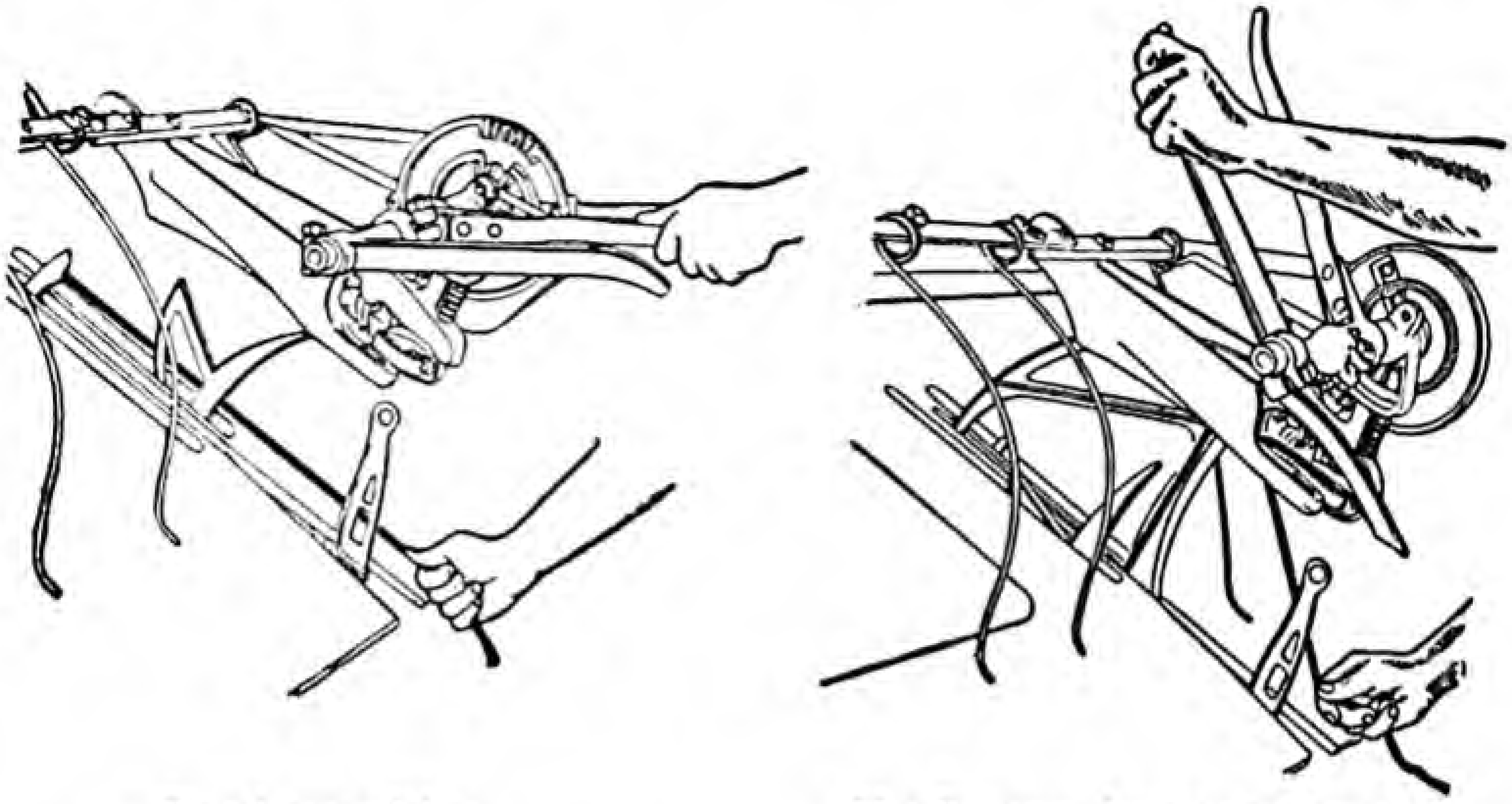


FIG. 487.—Method of testing and squaring up both the lower and upper elevators.

416. Tying Mechanism.—The needle brings the twine over the bundle of straw, placing it in the twine-holder disc, which holds it securely while the bill hooks revolve, wrapping the twine around the bills, catching the ends of the band between them, and holding it while the twine is pulled from over and around the bill hook, tying the knot. As the knot is tied and the cord cut, the twine-holder disc retains the end of the twine for tying another knot. The tension with which the twine disc should hold the twine differs somewhat with different types of twine discs, but, on the average, it will vary from 30 to 50 pounds as measured by an ordinary pair of hand scales. The cam gear is revolved on what is known as the *knotter shaft* upon which are placed the discharge arms. These arms are so placed that just at the time the knot is completed they come in contact with the bundle, forcing it out and discharging it onto the bundle carrier. The operation of the discharge arms also aids in finishing and completing the knot. In some types of knotters, the stripping of the knot from the bill hooks is done entirely by the discharge arms, forcing the bundle out. In others, they only aid the stripper arm in stripping the completed knot from the bill hooks.

The knife for cutting the twine for each band may be attached to either the stripper arm or held stationary against the twine disc. When the knot has been completed, the needle drops below the deck, and the discharge arms and the other parts of the knotter head are locked to

prevent turning until the proper amount of grain has been brought down for another bundle.



Starting position. Needle turned part way over.

FIG. 488.—Illustrations showing correct position to hold twine to get it attached to twine disc.

In general, there are two different types of knots tied by knotters; one ties a *straight knot*, while the other ties a *bowknot*. The type shown in Figs. 489*a* and 489*b* ties a straight knot. The type shown in Fig. 490

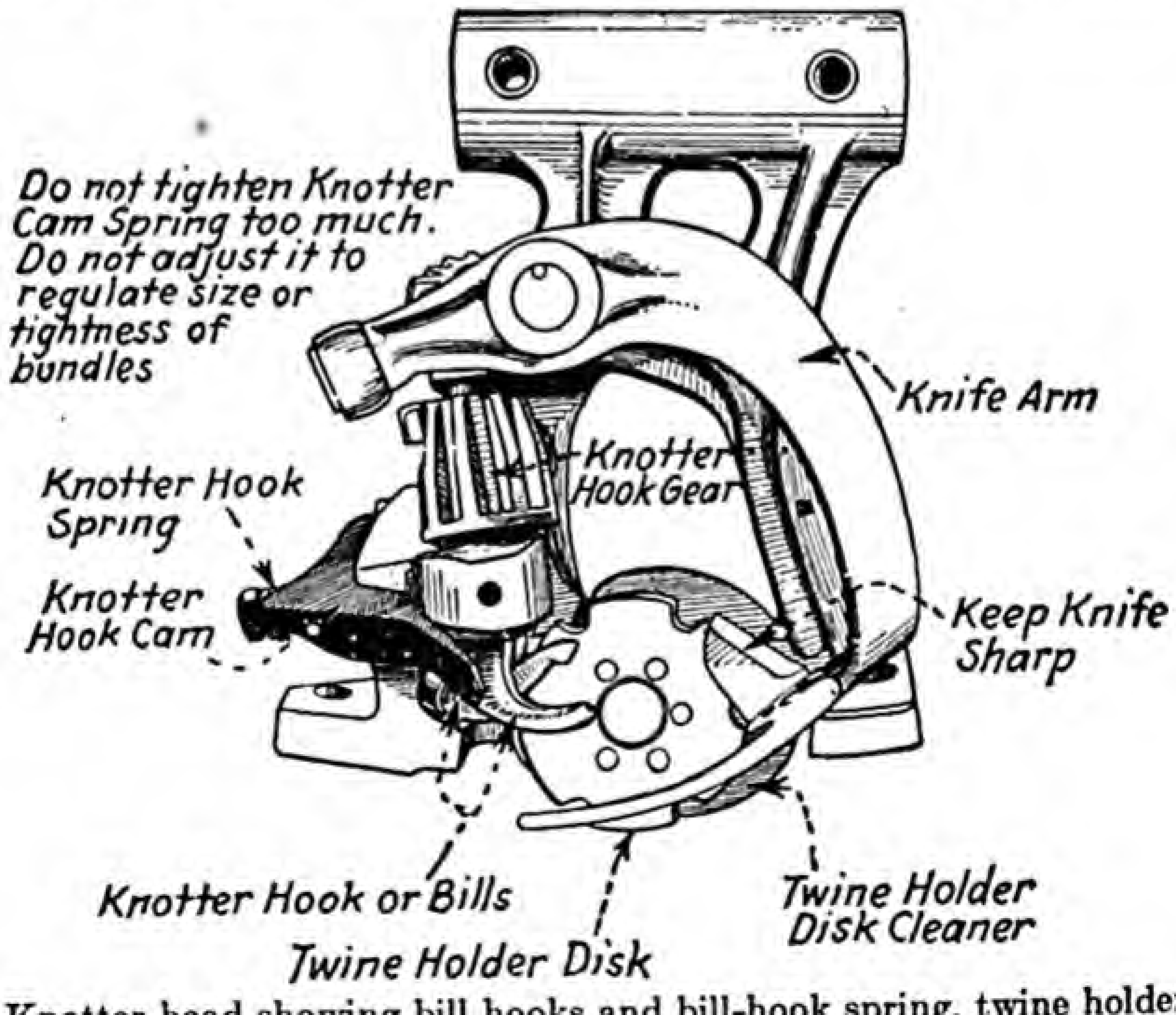


FIG. 489*a*.—Knotter head showing bill hooks and bill-hook spring, twine holder, and knife arm. This knotter ties a straight knot.

ties a bowknot. Some operators prefer the straight knot, arguing that a smaller amount of twine is used than for a bowknot. When a straight knot is tied, a small piece of twine is cut off and thrown away; when a

bowknot is tied, the amount of twine that would have been thrown away is included in the bow.

To give the twine the proper amount of tension, a special apparatus called the *twine tension* is used. There are three kinds: single-roller,

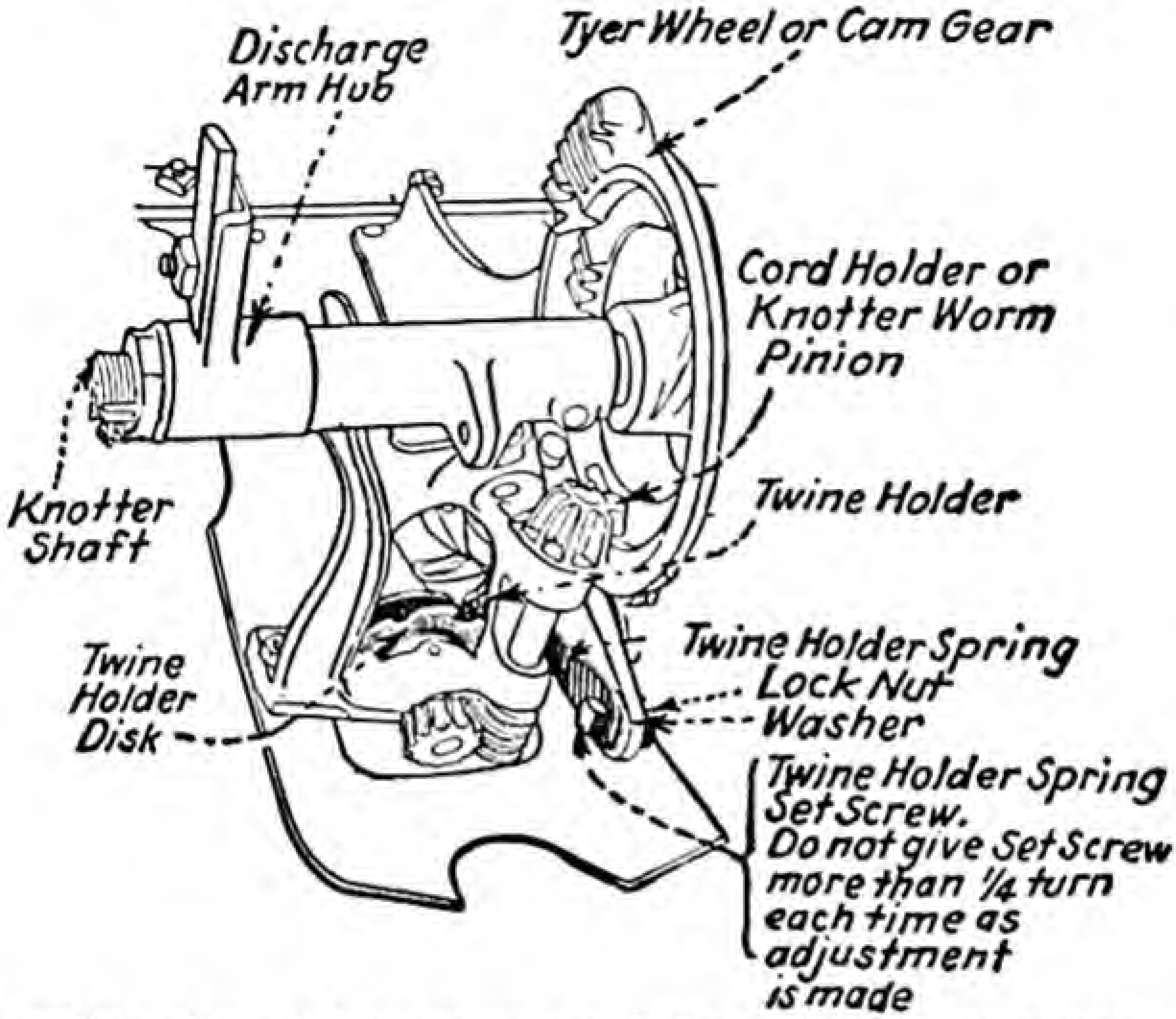


FIG. 489b.—Another view of the knotter head shown in Fig. 489a, showing twine disc holder and twine disc spring.

double-roller, and spring. In each of these types, the tension is regulated by a spring held by a bolt. When the nut of the bolt is turned down, the twine is pinched together, causing it to pull much harder. The amount of tension should be 6 to 8 pounds.

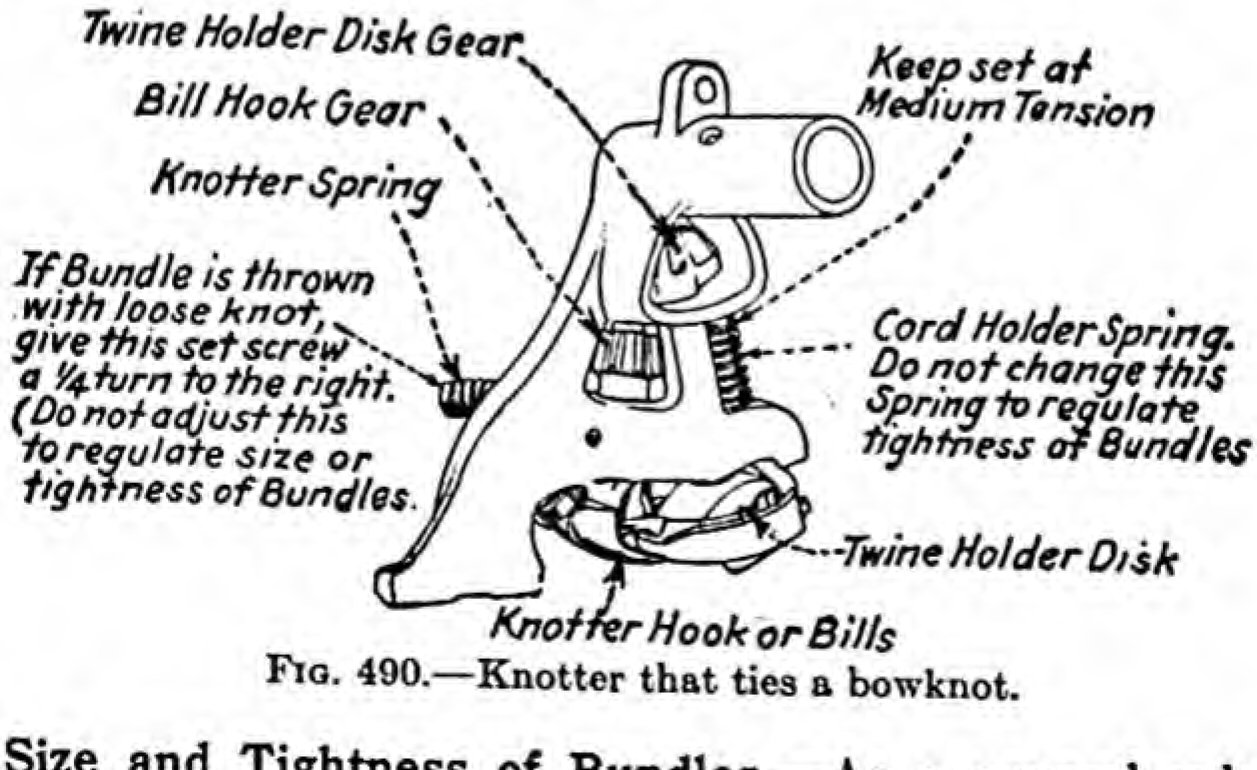


FIG. 490.—Knotter that ties a bowknot.

417. Size and Tightness of Bundles.—As a general rule, the size of the bundles is regulated by moving the trip hook in or out on the trip-hook arm, and by tightening and loosening the trip spring. How-

ever, when the trip spring is adjusted, it will also influence the tightness of the bundles.

418. Binder Troubles.—When looking over a binder out of adjustment, get all the information possible about the machine. Do not hurry. See that the machine is properly put together, chain tight, pawl and needle properly timed and in good working order; examine the knotter head, tying one or two sample knots, turn the binder attachment by the discharge arms. Do not make any adjustments until the binder has been carefully examined, even though it is thought that the trouble has been located. Remember that the binder was made to work right and for every trouble there is a cause and, therefore, a specific remedy. Never make any adjustment to correct trouble until certain this is exactly what is required. If, as is often the case, after certain adjustments have been tried, they do not have the desired effect, put them back as they were before making others. In inspecting a binder, it is necessary to reason from effect to cause. If this is properly done, the adjustments required to correct a trouble are usually few.

419. Chain and Gear Troubles.

1. *Chain:* Undue wear on the chains may be caused by their being too tight or backward.

Remedy: Loosen the tension or run the chain with the head of the links leading and slot outward.

2. *Oil:* The use of oil or grease in a sandy country will collect the fine particles of sand on the chain, causing it to wear very rapidly.

Remedy: Do not use oil or grease.

3. *Chains:* Chains sometimes will not stay on because the sprocket wheels are not in line. This may be caused from the boxes becoming worn, a bent wheel, or a bent shaft.

Remedy: Rebabbitt the boxes, get new sprocket wheel, or straighten the shaft.

4. *Gears:* Gears may act badly because of any of the following: gears being out of true, gears being out of line with each other, teeth meshing too tightly or not tightly enough, and the use of grease or oil in a sandy country.

Remedies: If the gears are not true, discard the old ones and put on new ones. If they are not in line, locate the cause and line up properly. If the teeth mesh improperly, remedy this by the mechanism provided for the purpose, if there is any, or look for wear on the boxes or shafts.

The gear wheels on a binder are seldom oiled or greased.

420. Canvas Troubles.

1. *Creeping:* The creeping of canvases may be caused by running them too loose or the elevators not being square.

Remedy: Square the elevators and see that the canvases are drawn tight. Have the tightness the same on both sides.

2. *Canvases not elevating the grain* may be caused by missing slats or loose canvases.

Remedy: Put on the missing slats and tighten the canvases.

3. *Broken slats* are generally caused by the elevators not being square or the canvases not being buckled evenly.

4. *Chewed slats* may be caused by a projecting bolt or the canvas guides being out of shape.

Remedy: Locate the cause of the trouble and remove.

5. *Slat binding:* Occasionally a slat or a number of slats are too long, causing binding.

Remedy: Saw off the slat or slats which are causing the trouble.

421. Binder-attachment Troubles.

1. *Pawl spring becomes weak:* As the pawl is the mechanical device by which the whole tying mechanism of the binder is put into motion, any trouble here will affect the whole, which makes a good basis on which to locate the pawl and pawl-spring troubles.

Pawl spring becomes weak, broken, or lost: This trouble may show itself in different ways. The pawl may fail to catch, and the tying mechanism may not move at all when the trip is pressed. The pawl may catch momentarily and then let go, leaving the needle part way up and the discharge arm halfway around.

Remedy: Examine the pawl spring carefully and if weak, broken, or missing, supply a new one.

2. *Pawl failing to set:* Often the face of the pawl and ratchet become worn round so that instead of catching they slide past each other. This occasionally causes many small bundles.

Remedy: File the face of the pawl and ratchet until they meet each other squarely.

3. *Pawl and pawl rollers become worn:* The pawl and pawl rollers often become worn, especially when not oiled properly. This will result in the binder mechanism not being put in action. If one is not careful, he may mistake a worn pawl roller for a weak pawl spring, and *vice versa*.

Remedy: Replace the pawl rollers and put on a new pawl if necessary.

422. Needle Troubles.—On practically all binders, the needle should be completely advanced, just as, or a little before, the knotter bill comes parallel with the knotter shaft.

1. *Slow needle:* Often as the mechanism which drives the needle becomes worn, it will not come up quickly enough for the disc to catch the twine; thus it fails to tie a knot, and the twine will not be caught in the disc, as it did not get there soon enough.

Remedy: Shorten the needle pitman to bring it into time.

2. *Bent needle:* By continued use in heavy grain, the needle point may become slightly bent upward, so that it does not bring the twine down into the twine disc and acts the same as a slow needle.

Remedy: The needle is the arc of a circle. Make a mark on the breastplate or deck where it comes through, and test. If bent up, take a gas pipe or something that you can grip well back on the needle and bend down again.

3. *Eye on needle worn:* The eye on the needle is made of especially hardened steel, but sometimes it becomes worn so badly that the twine will not be delivered into the disc.

Remedy: Some machines have a small wheel that can be replaced. Otherwise, if the needle cannot be advanced enough to remedy the difficulty, a new needle must be put in.

423. Knotter-shaft Troubles.

1. *Slow discharge arms:* The discharge arms must come around soon enough to pull the twine from the knotter bill hooks. If the arms are slow, a perfect bundle will be tied and left with some twine hanging to the bill hooks.

Remedy: Advance the knotter-shaft gear wheel on cog. Then time the needle properly.

2. *Discharge arms dropping when set:* In some machines the mechanism which drives the discharge arms is locked in such a way as to prevent their dropping. In other machines, they are held up by a cam on the knotter-shaft gear wheel. If the lock should become weak or broken or the cam wheel worn, the arms will drop, causing the needle to rise.

Remedy: Tighten the spring which locks the arms up.

3. *Troubles due to pawl:* If the arms should fail to revolve, revolve part way and stop, or revolve continuously, the trouble is with the pawl.

Remedy: See Binder-attachment Troubles.

4. *Throwing small bundles:* The throwing of small bundles may be caused by tangles—grain hanging on; a weak or broken spring; the faces of the pawl and pawl lock not being square with each other.

Remedy: If caused from heavy tangled grain, little can be done.

424. Knotter-head Troubles and Remedies.[1]—The condition of the band is the best indicator of the source of trouble. *If the bundles are not tied, examine the bands.* The various types of bands shown in Fig. 491 show the condition of the band caused by different troubles.

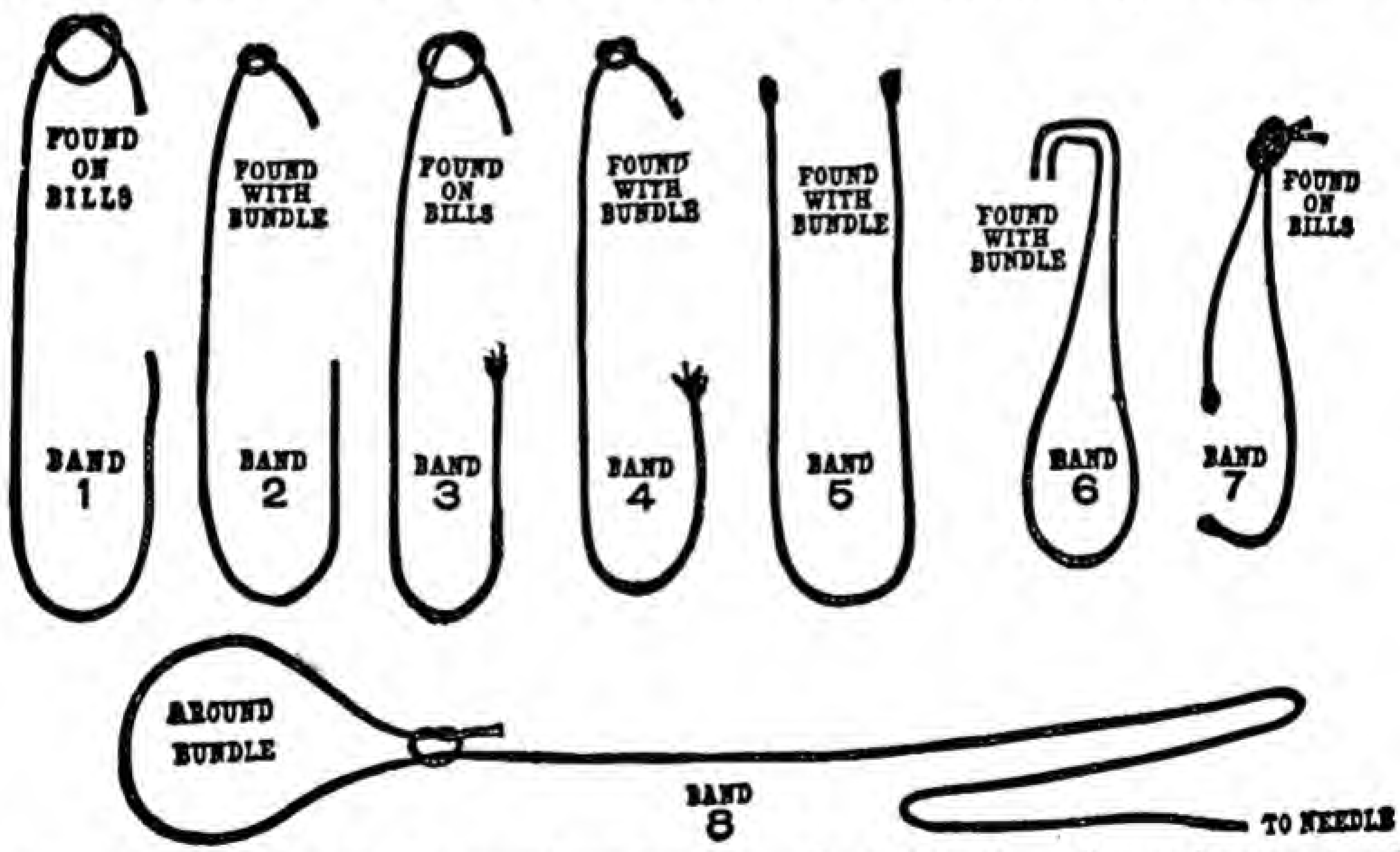


FIG. 491.—Condition of bands and where found as affected by the different knotter troubles.

Band 1 is found clinging to the bill hooks with a loose knot tied in it; the other end is cut smooth and square.

[1] For more detailed explanation, see *Ohio Ext. Ser. Bull.* 87, p. 87, 1935.

Cause: The twine-disc spring is too loose, and the twine tension may also be too tight.

Remedy: Tighten the twine-disc spring and loosen the twine tension.

Band 2 is similar to band 1 except it is found with the bundle and the knot is drawn down fairly tight. The free end is cut smooth and square.

Cause: The twine-disc spring is too loose but the twine tension is in good condition.

Remedy: Tighten the twine-disc spring but do not bother the twine tension.

Band 3 is found on the bill hooks as in band 1 but the free end is crushed and frayed out.

Cause: The twine-disc spring is too tight and the twine tension is also too tight—just the reverse of band 1.

Remedy: Loosen the twine-disc spring and tighten the twine tension.

Band 4 is found with the bundle with the knot drawn close and the free end crushed and frayed out.

Cause: The twine-disc spring is too tight. Nothing wrong with the twine tension.

Remedy: Loosen the twine-disc spring only.

Band 5 is found with the bundles with both ends of the band crushed and frayed out.

Cause: The twine-disc spring is even tighter than in band 4. The twine tension is perfect.

Remedy: Loosen the disc spring gradually.

Band 6 is found with the bundles. Both ends show that they have been wrapped around the bill hooks to form the knot but not completed. They are bent and crinkled.

Cause: The bill-hooks spring may be too loose; or the *hump* on the underside of the upper bill may be worn away so the bills cannot hold the ends of the band securely enough when the knot is about to be completed.

Remedy: Tighten bill-hooks spring; replace bill hooks with new ones; a rattail file will aid in deepening the groove so the twine can be held better.

Band 7 is found on the bill hooks with the knot completed but the band broken at some other place.

Cause: The bill-hooks spring is very tight, with loose bundles, or the stripper-arm cam is worn, preventing the knots being stripped from the hooks.

Remedy: Loosen the bill-hooks spring; replace the stripper-arm cam.

Band 8 is found with the slip noose tied around the bundle with the twine extending to the eye of the needle.

Cause: The eye of the needle is badly worn back and the needle cannot advance far enough to place the twine in the twine-holder disc.

Remedy: Renew the roller in the needle eye or put on a new needle.

In attempting to make adjustments for any of the above troubles, make them gradually and one at a time. Turn the nuts or setscrews, as the case may be, only a quarter of a turn each time a change is made. If the trouble is not overcome, put all changes made back to their original positions. Then try something else.

425. Miscellaneous Troubles.

1. *New machine failing to start:* Occasionally a new machine fails to start, owing to some part sticking or catching.

Remedy: Test out for the trouble. Throw the binder out of gear and see that the bull wheel revolves without catching. Remove the elevator chain and throw in gear. This will test the sickle. Next, put on the elevator chain and disconnect the reel. This method will test one part at a time and should locate the trouble without difficulty.

2. *Hot boxes:* The heating or cutting out of boxes may be caused by the boxes being too tight, improper alignment with the shaft, or lack of proper lubrication.

Remedy: If the box is solid, rebabbitt and see that it receives plenty of good lubricating oil. If it is a split box and it heats, put shims between the two halves and oil well. Of course, if any box is badly worn, line properly with the shaft and rebabbitt.

3. *Badly shaped bundles:* Poor bundles in good grain are caused from improper manipulation of the binder.

Remedy: Reel the grain properly; retard the heads and keep the butt adjuster straight.

4. *Heavy draft:* Heavy draft may be caused from lack of sufficient good lubricating oil; from the bull wheel being centered in the quadrant wrong; from the chains, especially the main drive chain, being too tight; and from paint or varnish not being cut out of the bearings.

Remedy: Apply lubricating oil to bearings. Center the bull wheel in the quadrant, square. Have the proper tension on the chains. Kerosene oil will cut the paint or varnish from the bearing surfaces.

5. *Side draft:* Side draft is usually caused by the grain wheel bearing being too tight or out of line. Long cutter bar.

Remedy: Arrange the bearing so that there is no undue friction and see that it runs straight.

6. *Horses:* A fast horse on the outside will sometimes make trouble with the draft of a binder.

Remedy: Put the fast horse next to the grain.

7. *Getting the grain from the elevator to the packer:* Trouble is sometimes experienced in getting light fluffy grain to the packers.

Remedy: See that the seventh roller is working properly and lower the deck cover.

426. Binder Tractor Hitch.—With the large amount of motor power, in the form of tractors, available for the drawing of binders, some special type of hitch should be provided. There are many types of patented hitches for such work that allow one binder to be drawn by itself, or two or more can be hitched tandem and operated successfully with one tractor. Some of these tractor hitches do not require any aid for steering on the part of the operator of the binder.

427. Care of the Binder.—At the end of the cutting season special care should be given the binder before it is put away for the winter. Putting away should not mean that it is set out in the barnyard or left in some fence corner. The binder should be placed under a shed to protect it from weather conditions and to prevent decaying of the wooden parts and rusting of the metal parts. While the team or tractor is still hitched to the binder, all parts should be gone over thoroughly, and all bearings and points of wear given a thorough soaking in oil. Then the binder

should be run for 1 or 2 minutes to get the oil thoroughly worked into the bearings; then, when it is put in the shed and left for several months, these bearings will not be rusted and probably stuck, requiring considerable time to get them in shape for the following season. In addition to this, as much of the dust and caked oil should be removed as possible before it is set away. Also, just at this time, when all the troubles that have been encountered during the cutting season are fresh, they should be set down on a piece of paper so that repairs can be readily made during the slack season. This is especially necessary where it is likely that the same operator will not be with the binder during the next season. The canvases should all be removed, cleaned, rolled up, and put where there is no danger of rats or mice cutting them.

428. Draft of Binders.—The draft of a binder is affected by the kind of grain being cut, the yield, the condition and type of soil, and the grade and condition of the binder. Therefore, the draft will vary greatly. This variation may be from 60 to 100 pounds per foot in width covered. This would require 1.3 to 2.2 horsepower hours per acre.[1]

429. Acres Cut per Day.—The number of acres of grain harvested per day will vary according to the conditions. A 4- to 7-foot binder drawn by three horses will cut 1.79 acres per foot of width of cutter bar in a 10-hour day. A 5- to 8-foot binder drawn by four horses will harvest 2.08 acres per foot of width of cutter bar in a 10-hour day.[1]

A tractor binder will harvest from 15 to 35 acres per day depending on conditions and size and rate of travel. A 10-foot binder traveling at the rate of 3 m.p.h. will harvest 35 acres per 10-hour day.

[1] *Extension Service Handbook on Agriculture and Home Economics*, U. S. Dept. Agr., 1926.

CHAPTER XXII

CORN-HARVESTING MACHINERY

CORN BINDERS

The corn binder was designed and built primarily for cutting corn. It is adaptable, however, to cut and bind into bundles any crop commonly grown in rows, such as corn, sorghum, soybeans, sunflowers and other crops that grow tall enough to be handled by the machine. Consequently, it is often called a *row binder*. In operation, the corn binder

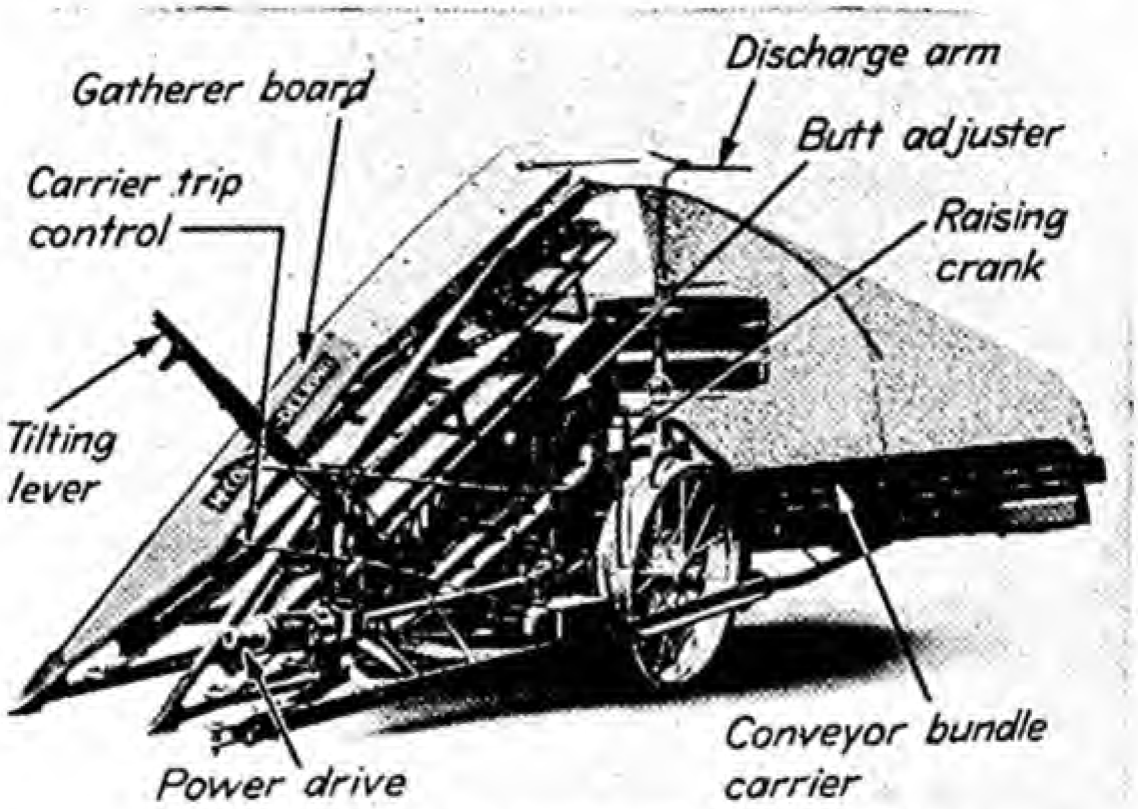


FIG. 492.—One-row power-driven row binder.

severs the stalks from the ground, gathers them into bundles, ties a twine around the bundles, and discharges them directly onto the ground or onto a bundle carrier which discharges them one or more at a time. If a loading attachment is used the bundles may be deposited onto a wagon or truck. Corn binders may be classified as to power requirements—ground-driven horse-drawn (Fig. 492) and power-take-off tractor-operated binders (Fig. 493). There are also *long* and *short* binders for binding crops of different height. The principal difference between the horse-drawn and the tractor-operated row binder is that the latter is equipped with parts for a power drive.

Binders may be named according to the position of the binding mechanism—vertical and horizontal. The vertical type binds the bundles standing in a vertical position, while the horizontal type binds the bundles in a horizontal position.

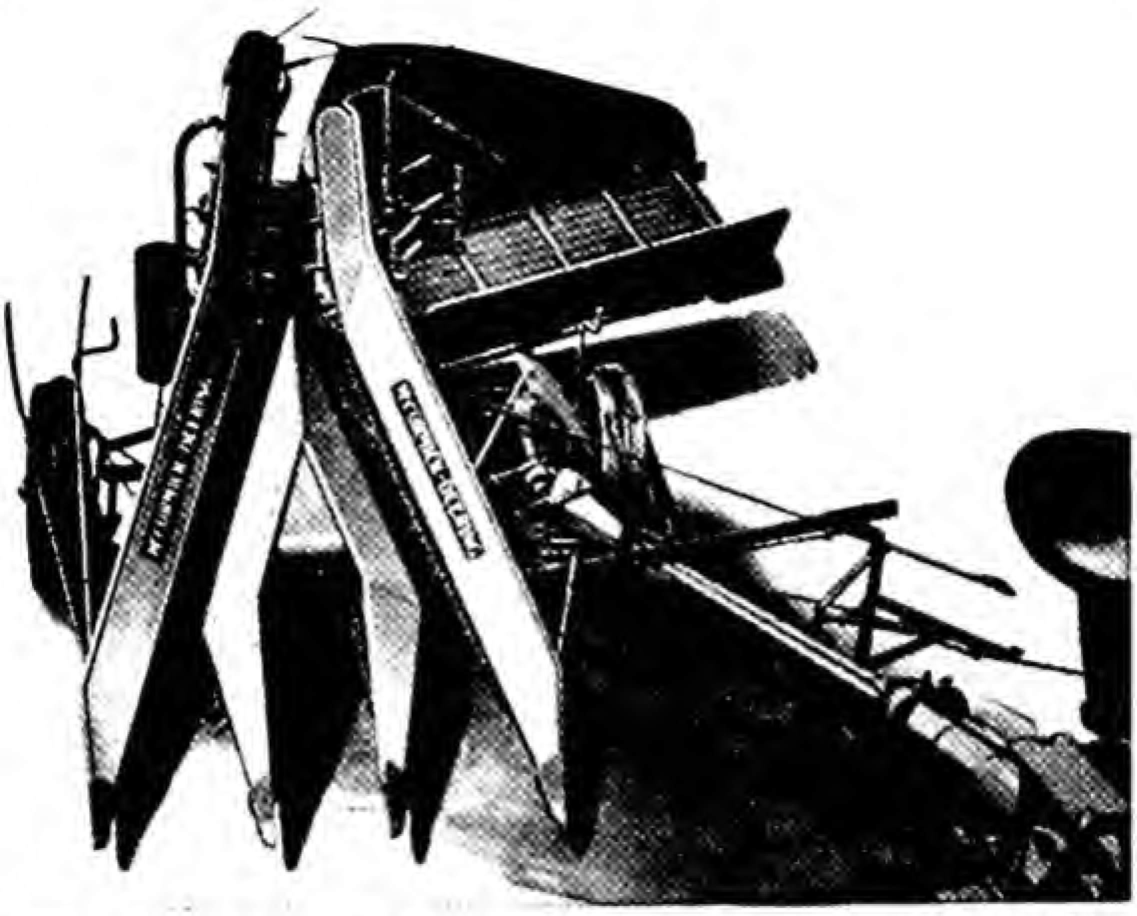


FIG. 493.—Front view of two-row power-driven tractor row binder.

430. The Driving Mechanism.—The power for driving the various parts of a horse-drawn row binder is furnished by the ground-traction bull wheel. The power-drive tractor binder is operated entirely by power from the tractor, which is transmitted from the power-take-off

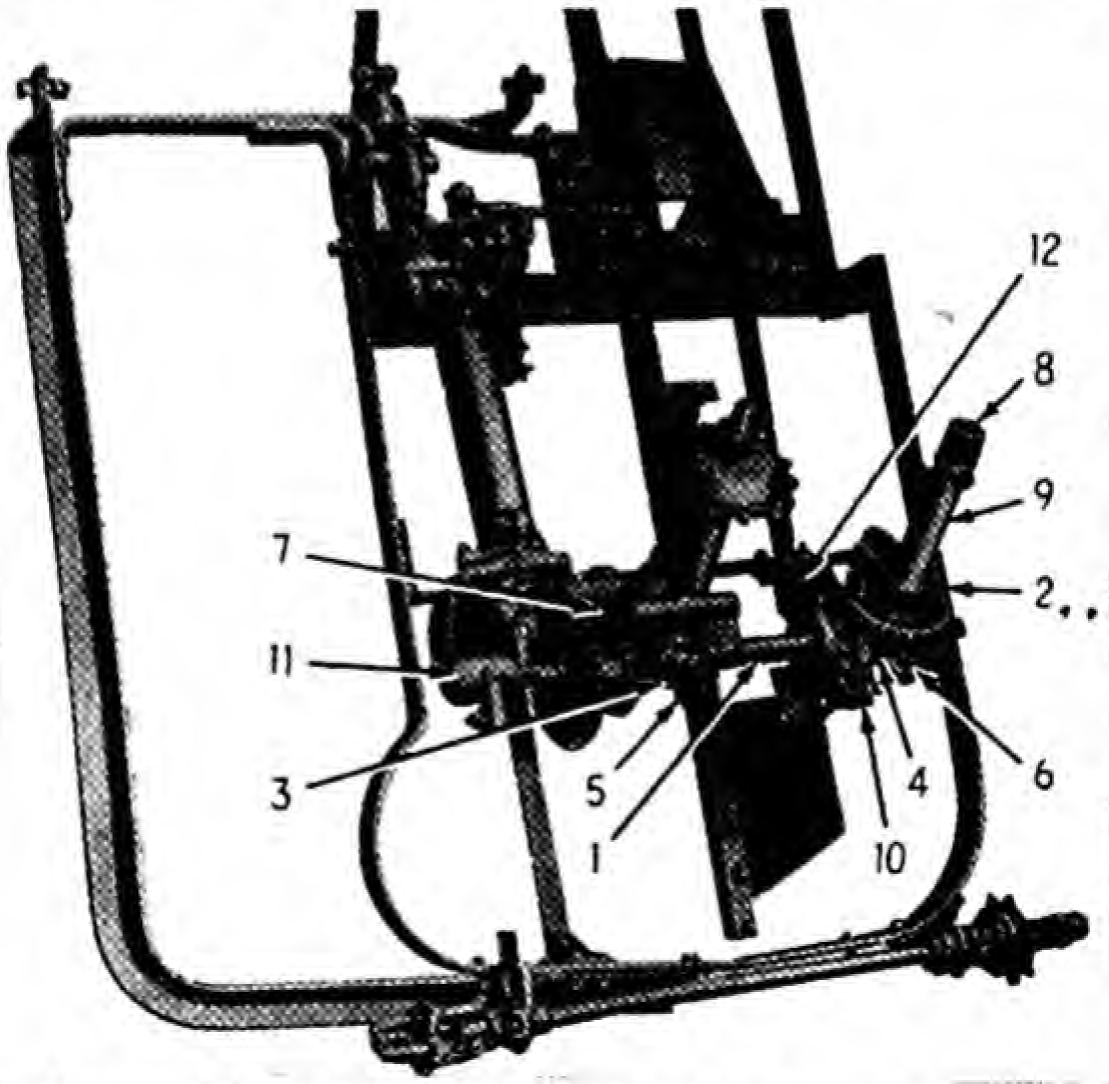


FIG. 494.—Main frame, sickle and knives, and driving mechanism for one-row power-driven tractor row binder.

through a propeller shaft equipped with universal joints for turning and a snap or slip clutch for safety (Fig. 494). Power to the sickle, the gathering chains, the binding mechanisms, and the bundle carrier is transmitted by gears, sprockets, and chains (Fig. 494).

431. The Cutting Mechanism.—The row-crop plants are severed from the ground by a single-section pitman-driven sickle reciprocating across two side knives (Fig. 495).

In fighting the corn borer it is important that the stalks be cut below the surface of the ground to destroy all larvae. Several low-cutting

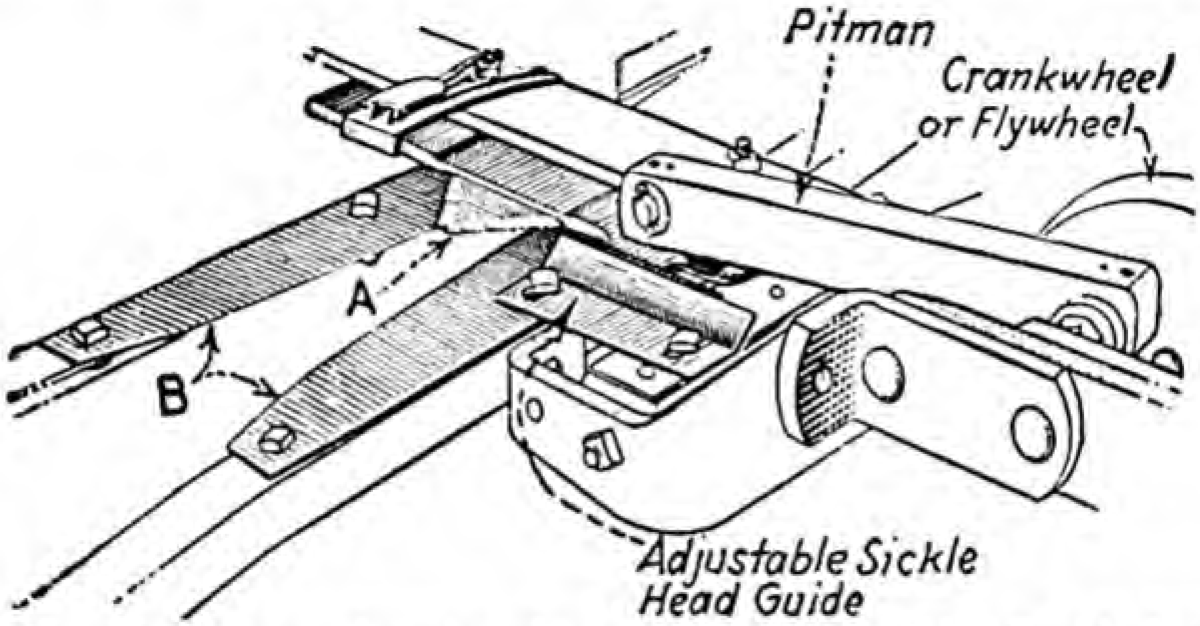


FIG. 495.—Cutting mechanism of corn binder: *A*, sickle; *B*, side knives.

attachments for corn binders, similar to the one shown in Fig. 500, have been developed.

432. The Elevating Mechanism.—As the plants are severed by the cutting mechanism, gathering chains equipped with lugs (Fig. 496) catch

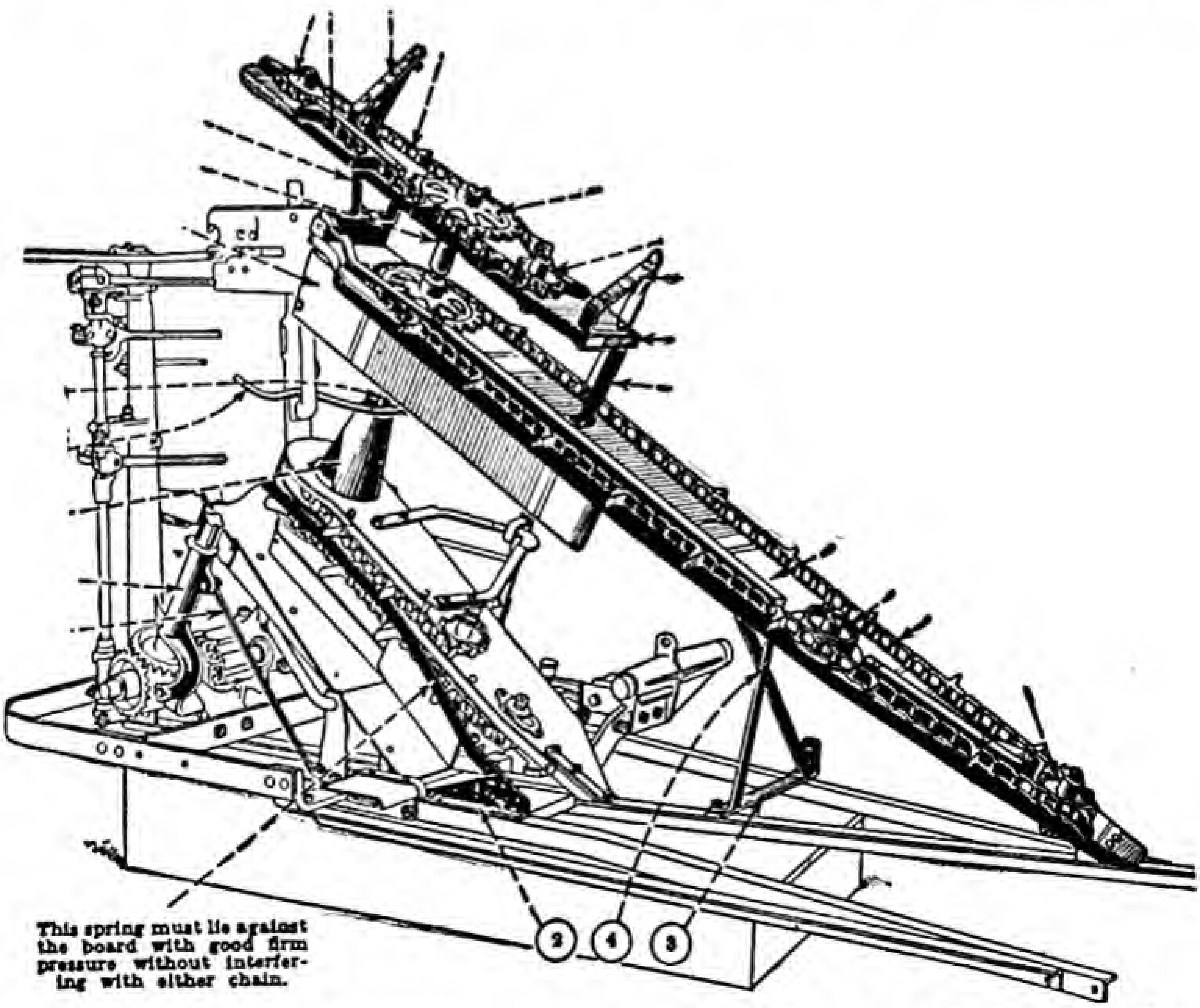


FIG. 496.—Side view of upper and lower gathering chains on left side of binder.

both the top and bottom of the plants and convey them back to the tying mechanism.

433. The Binding and Tying Mechanism.—The gathering chains deliver the stalks to the packer arms (Fig. 497), which pack them against the trip arm, which in turn trips the clutch engaging the tying mechanism. The tying of the knot and construction of the knotter are the same as on a grain binder.

Large *bundle loaders*, as shown in Fig. 498, can be secured to elevate the bundles directly to the wagon or truck traveling alongside the binder.

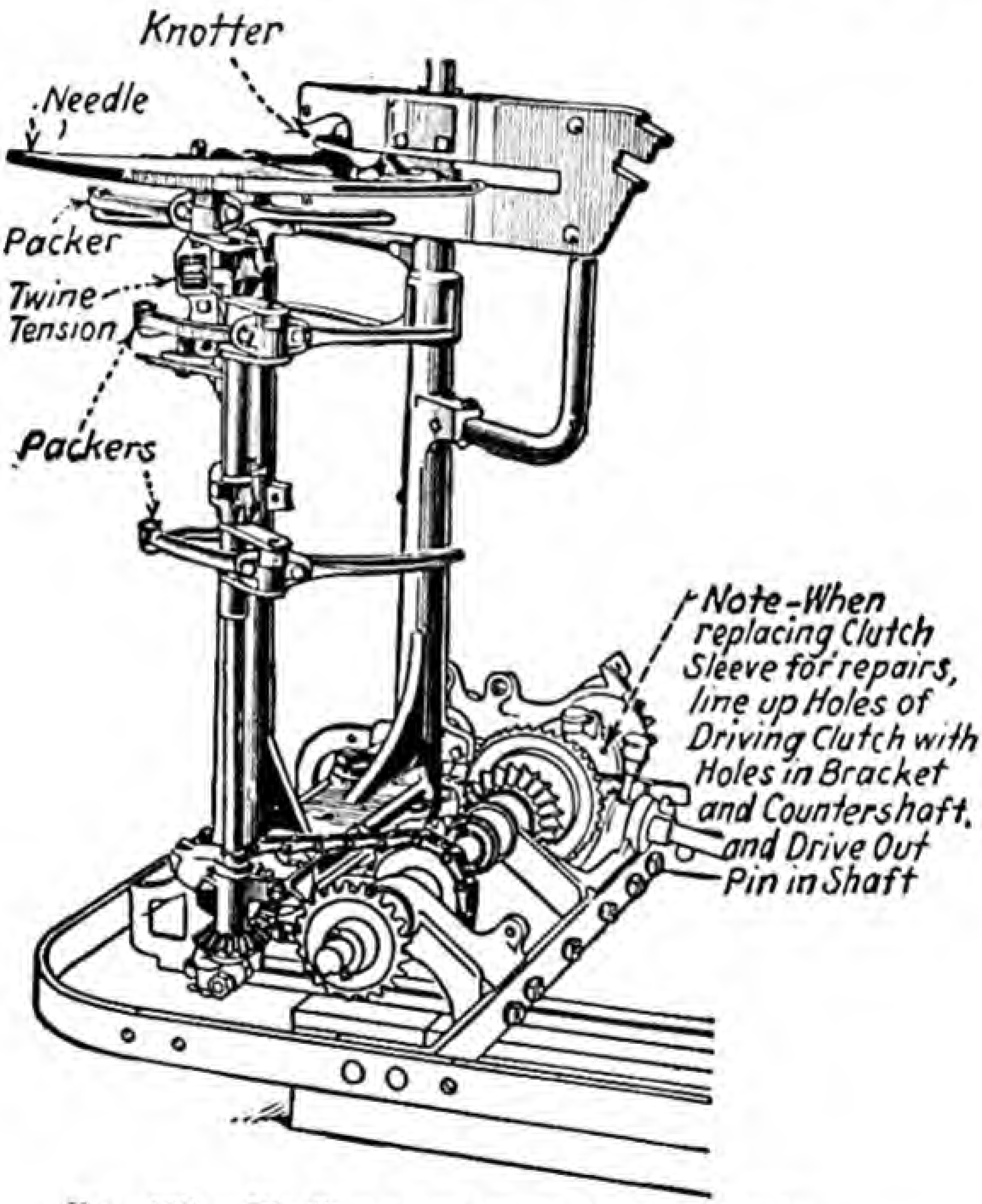


FIG. 497.—Binding attachment for corn binder.

Such a carrier would be a great labor saver in handling material being cut for silage.

434. Acres Cut per Day.—Under normal conditions a row binder drawn by three horses can cut about 7 acres in a 10-hour day.

435. Cost of Use.—Tolley[1] states that the average life of a row binder is 11 years, but during that time it will do perhaps only 40 days' actual work. He further states that there is little relation between the amount of work done annually and the years of service. The cost per day used

[1] *U. S. Dept. Agr. Farmers' Bull.* 992, p. 10, 1918.

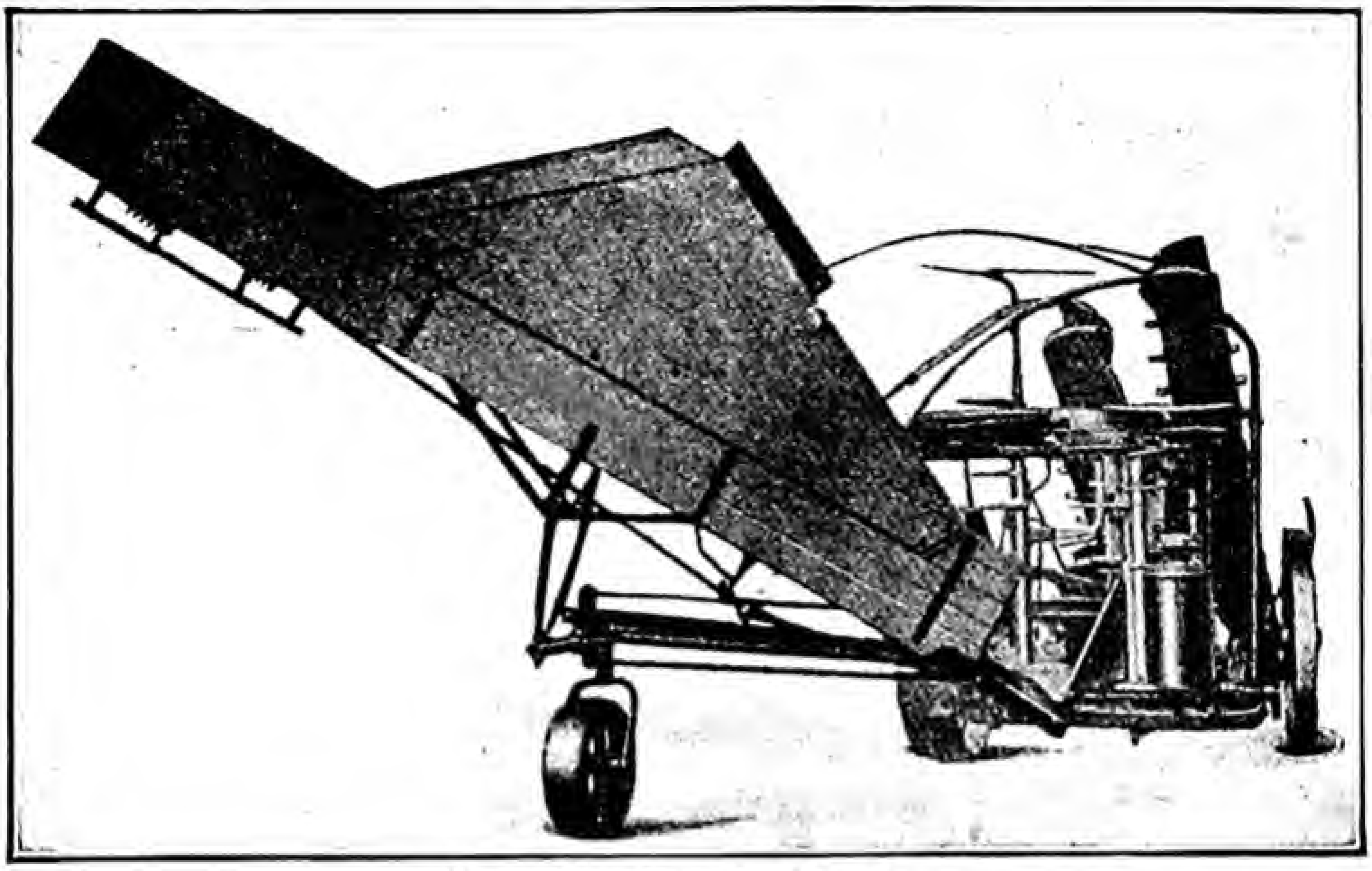


FIG. 498.—Bundle elevator.

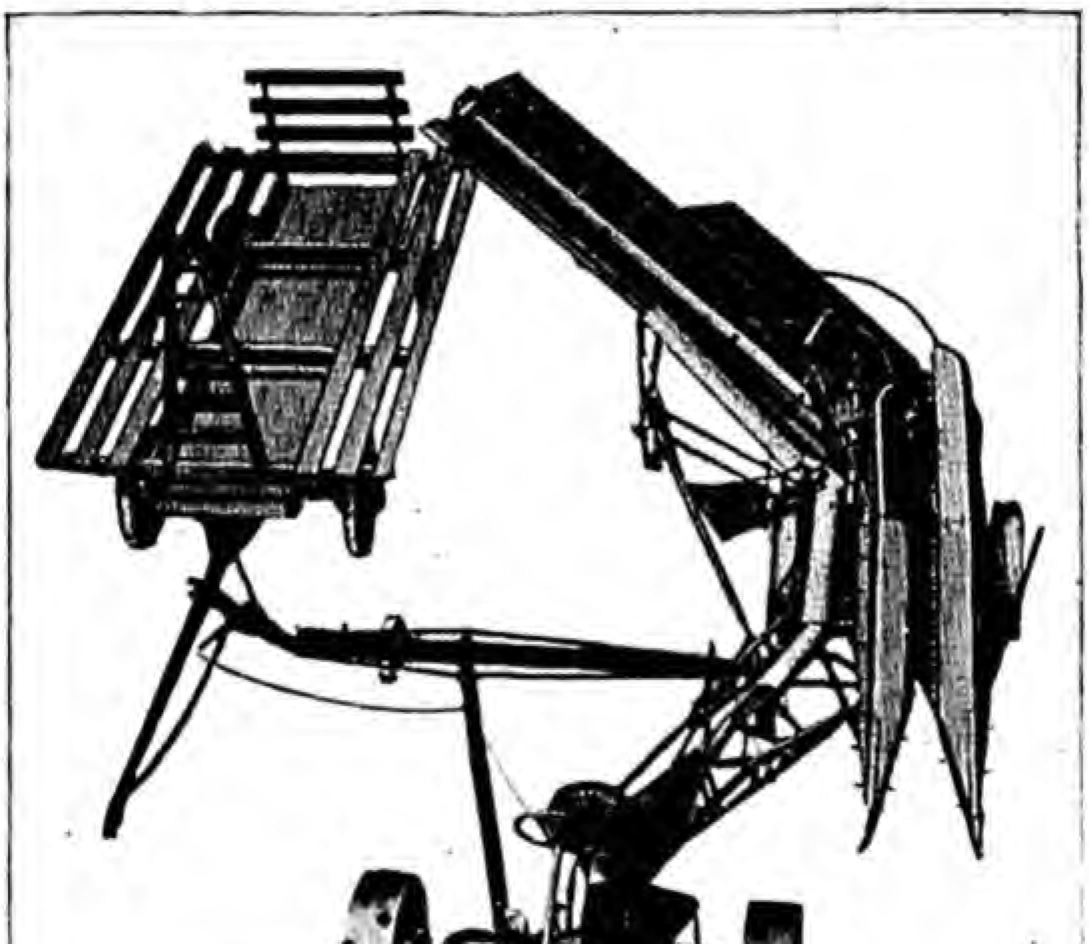


FIG. 499.—Overhead view of a tractor corn binder with bundle elevator, wagon hitch, and wagon in position.

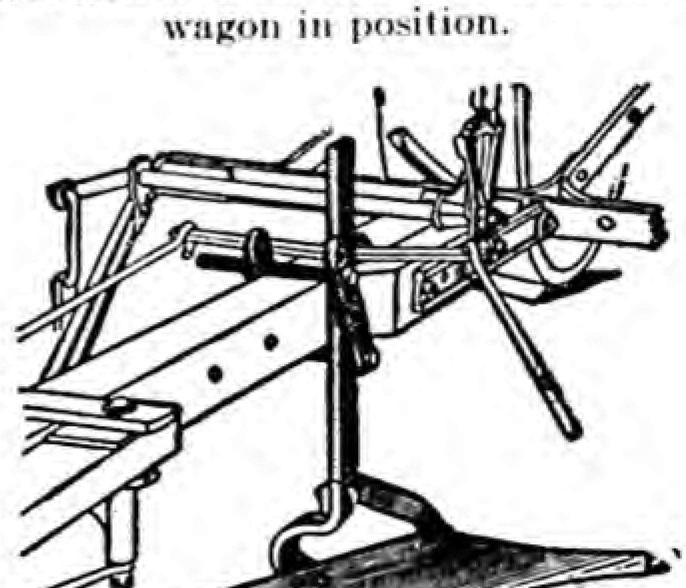


FIG. 500.—Low-cutting attachment for corn binder.

or per acre cut is very nearly in inverse ratio to the ground covered annually. Out of 456 binders on which data were obtained in western New York, 223 cut 15 acres or less annually . . . at a cost of $4.75 per day. The remaining 223 cut more than 15 acres annually, averaging 32½ acres, at a cost of $5.24 per day of service and 57 cents per acre.

CORN PICKERS

The corn picker is a single- or double-row machine, equipped with snapping rolls to remove the ears from the standing stalks. As the corn picker is a great time and labor saver, it is being used extensively to replace the slow, hard, hand method of harvesting. Only one man is required to operate any of the power-driven one- and two-row pickers shown in Fig. 301a. Additional help may be required to haul and place the corn in the bin. The gatherer sides and chains guide the stalks into the throat between the downwardly revolving snapping rolls, which pinch and snap the ears from the stalk. The ears are deflected into an elevator system which conveys them to a wagon or trailer drawn either beside or behind the machine. Most machines do not sever the stalks from the ground.

Machines are available for harvesting corn in three different ways. The simplest machine snaps the ears from the stalks and does not remove the husks. This type of machine is called a *snapper*. Most machines used in the Corn Belt are equipped with a husker attachment which in addition to snapping the ears from the plant also removes the husks. This type of machine is called a *picker-husker*. A more recent development is a machine that snaps the corn and shells it in the field. This type of machine is called a *picker-sheller*. There is also a type that shreds the stalks after the ears have been removed. This type is called a *picker-shredder*.

Generally, however, corn pickers are classified according to the number of rows harvested and the way the machines are attached to the tractor. Figure 301a shows one- and two-row tractor-mounted types and one- and two-row pull types of corn pickers. Each method of harvest has its advantages and disadvantages. The pull types are unit machines which can be easily attached and detached from the tractor. With them, however, the operator must look back and to the side to watch the machine. At least three unpicked rows of corn are broken down by the tractor and wagon in opening a land through the field. With the tractor-mounted type time is required to mount the machine, and the tractor cannot very well be used for other work while the machine is mounted. Some machines are more easily mounted than others. With the tractor-mounted machine the operator can steer the tractor and

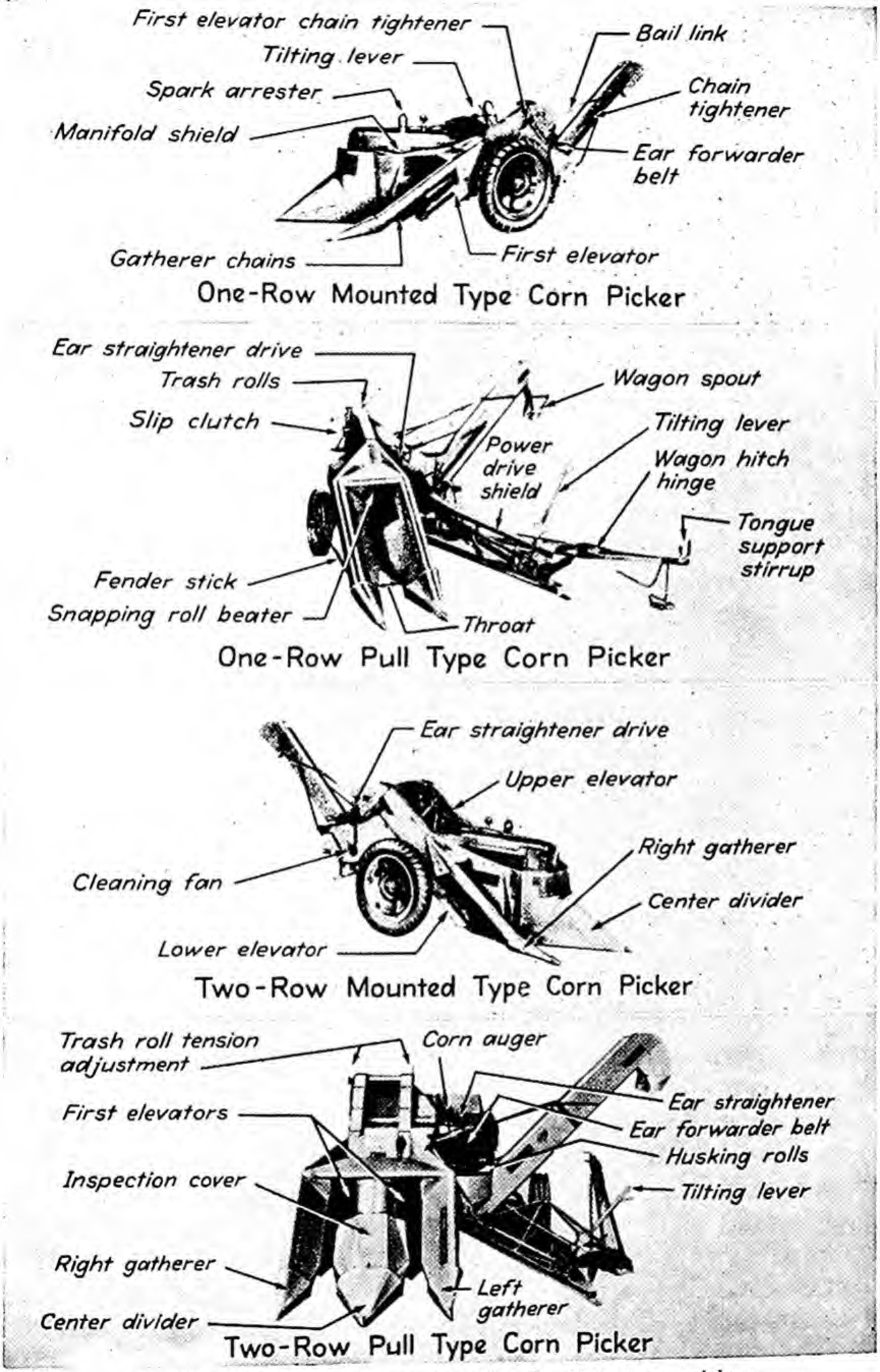


FIG. 501*a*.—Types of tractor-mounted and pull-type corn pickers.

FIG. 501b.—Two-row corn picker equipped with stalk shredders.

watch the machine without any neck twisting. With this type of picker a land can be opened through the field without breaking down extra rows. The wagon or trailer is drawn behind the machine. An estimate of the percentages of the corn acreage in different regions harvested by corn pickers is given in Chap. XXXVI.

436. Driving Mechanism.—Some early corn pickers were horse-drawn, but all present makes are power-driven by the tractor power-take-off. The power from the tractor is transmitted back to the picker by a long drive shaft. From a gear box at the rear end of the drive shaft the power is transmitted to the various picker units by a long countershaft. The tractor-mounted types require shorter drive shafts and countershafts. Slip clutches are provided for each of the various functional parts.

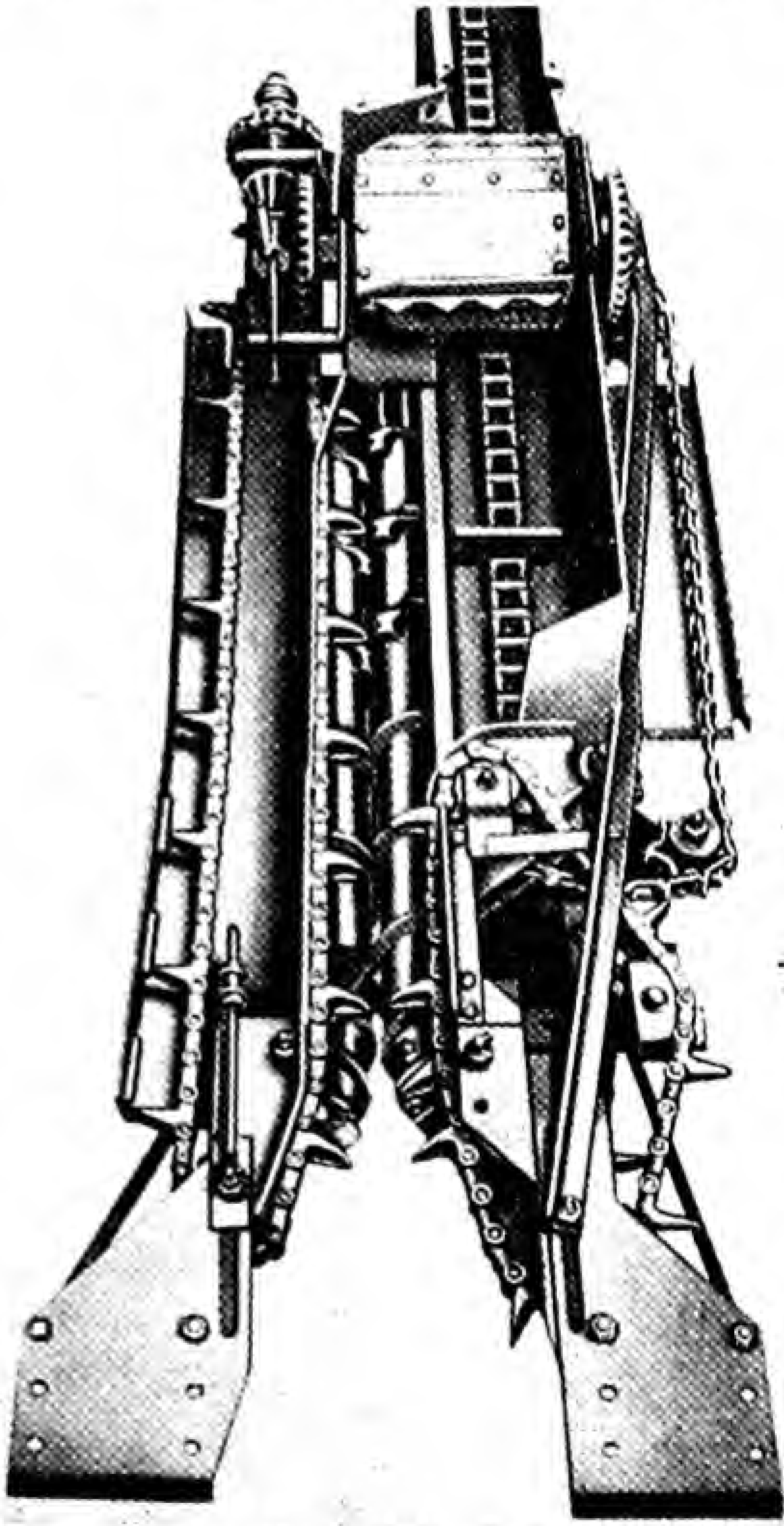


FIG. 502.—Corn-picker unit with shields and gathering points removed to show gathering chains, snapping rolls, and conveyors.

437. The Snapping and Gathering Mechanism.—There is no difference in the gathering and snapping mechanism of the one- and two-row pull types and tractor-mounted types, except that for the two-row pickers an

extra unit is added. On a two-row picker the middle divider point is always hinged, while the side gatherers on the one- and two-row pickers may or may not be hinged (Fig. 501*a*). The hinging of the points permits them to be set close to the ground and to follow the contour of the surface, thus slipping under and picking up stalks lying close to the ground. As the stalks are guided into the throat by the gatherer points,

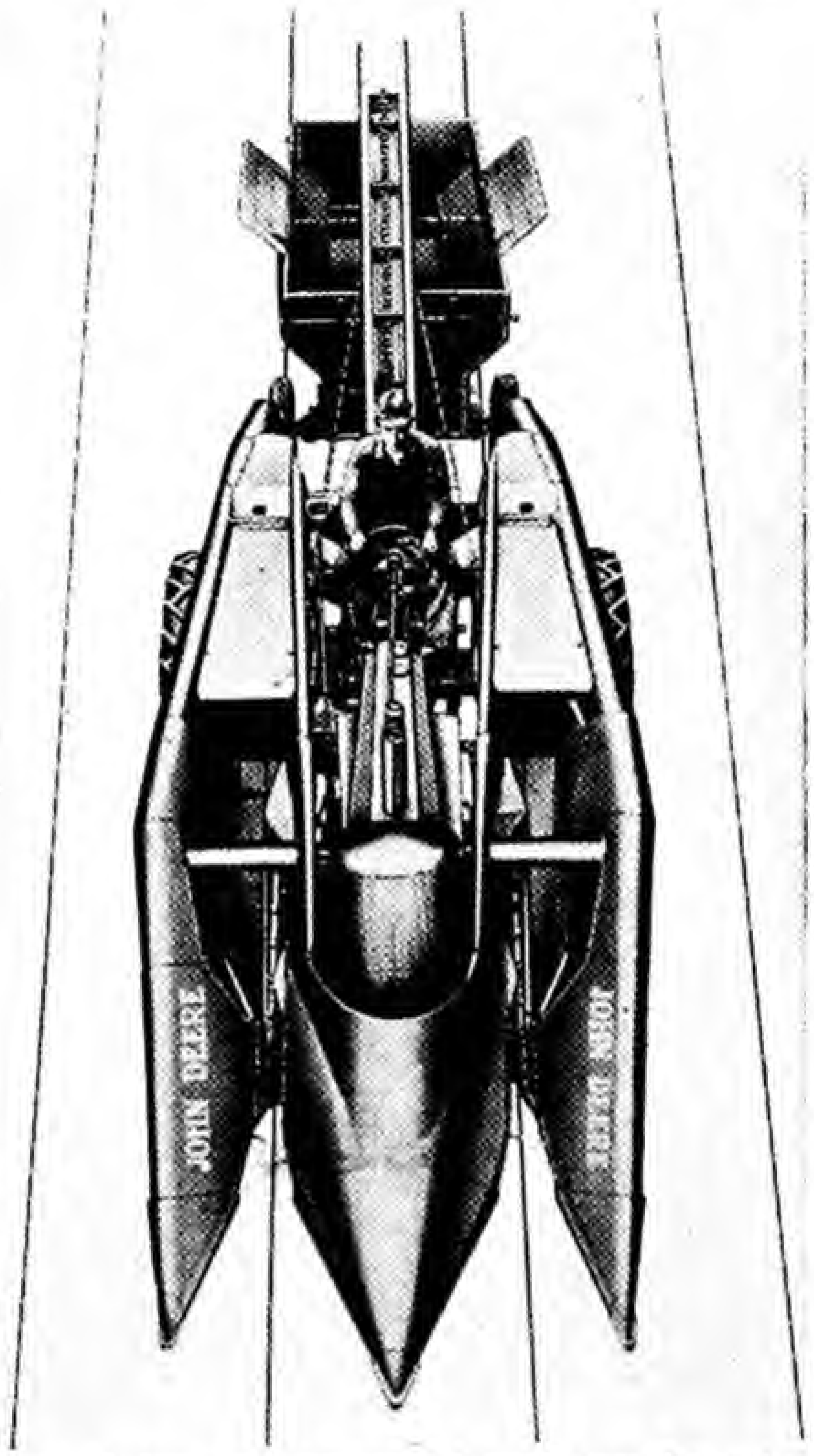


FIG. 503.—Overhead view of two-row power-driven integral tractor-mounted corn picker showing position of operator and wagon.

lugged gatherer chains assist in feeding the stalks in between the snapping rolls. Spiral lugs (Fig. 502) on the downwardly revolving snapping rolls catch the stalks, pull them down, and discharge them under the machine. The design and shape of the corrugated lugs on the snapping rolls differ with the various makes of machines. As the stalks are pulled down between the snapping rolls the ears are pinched off. Ordinarily the outside roll is set a little higher than the inside roll, and this aids in deflecting the ears into the conveyor elevator to one side, if it is a one-row picker, and in between the units if a two-row picker. The snapping rolls should

be adjusted according to the manufacturer's instructions. If the machine is of the picker-shredder type the stalks are severed from the ground, the ears snapped off, and the stalks shredded with hammerlike shredder knives. Shredding of the stalks aids in the control of the corn borer.

438. The Conveying and Elevating Mechanism.—As the ears fall from the snapping rolls they are conveyed back and elevated so they

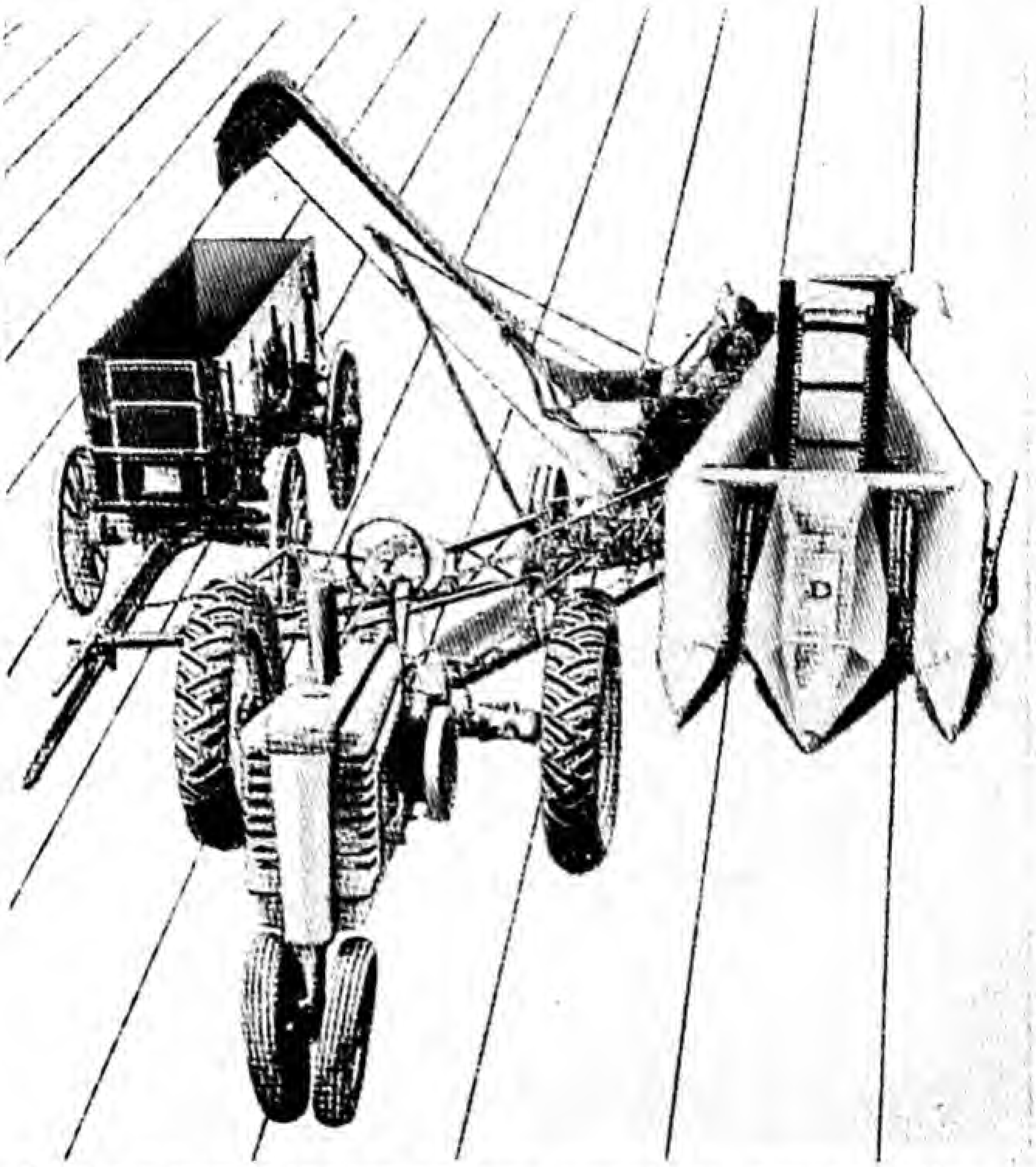


FIG. 504.—Overhead view of two-row pull-type corn picker, showing position of wagon in relation to picker and tractor.

can be dropped into either the wagon elevator through an air blast or into the husker or sheller units.

439. The Husking Mechanism.—The husking rolls may be set in line with the snapping rolls or they may be part of an interchangeable attachment set across the rear of the machine. The husking rolls, as shown in Figs. 506 and 507, operate in pairs with each pair held together under spring pressure, which can be regulated. There should be just enough tension on the rolls to cause them, with the aid of corrugations and husking pins on the rolls, to grasp the husks and pull them through the rolls so that the ears are stripped clean with a minimum amount of

shelling. Pressure on the retarding plates can be adjusted for large and small ears. The number of rolls in a husker ranges from eight to twelve.

Some corn pickers are equipped with a fan to blow the husks and trash off the husking rolls.

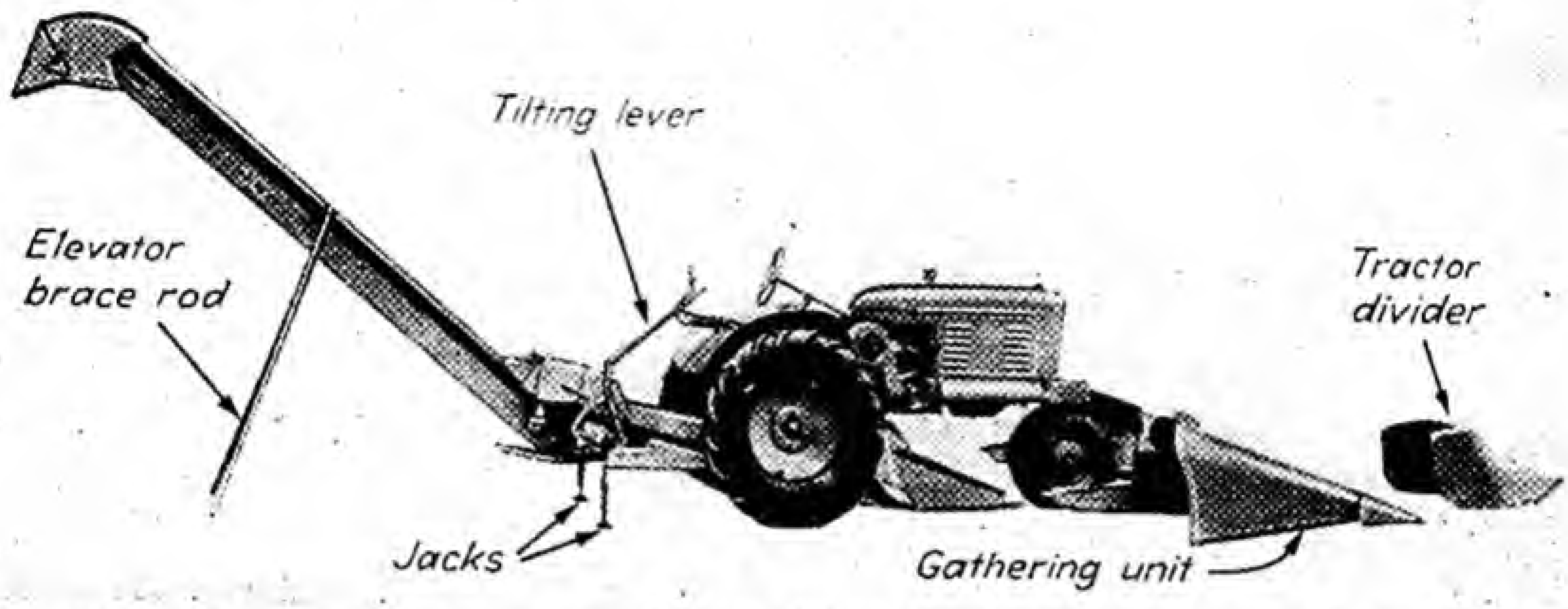


FIG. 505.—Two-row tractor-mounted corn picker showing how units can be easily detached from tractor.

Any corn shelled by the husking rolls is gleaned as it drops into the grain saver.

440. The Shelling Attachment.—Figure 509 shows a two-row pull-type corn picker equipped with shelling attachment. The corn is

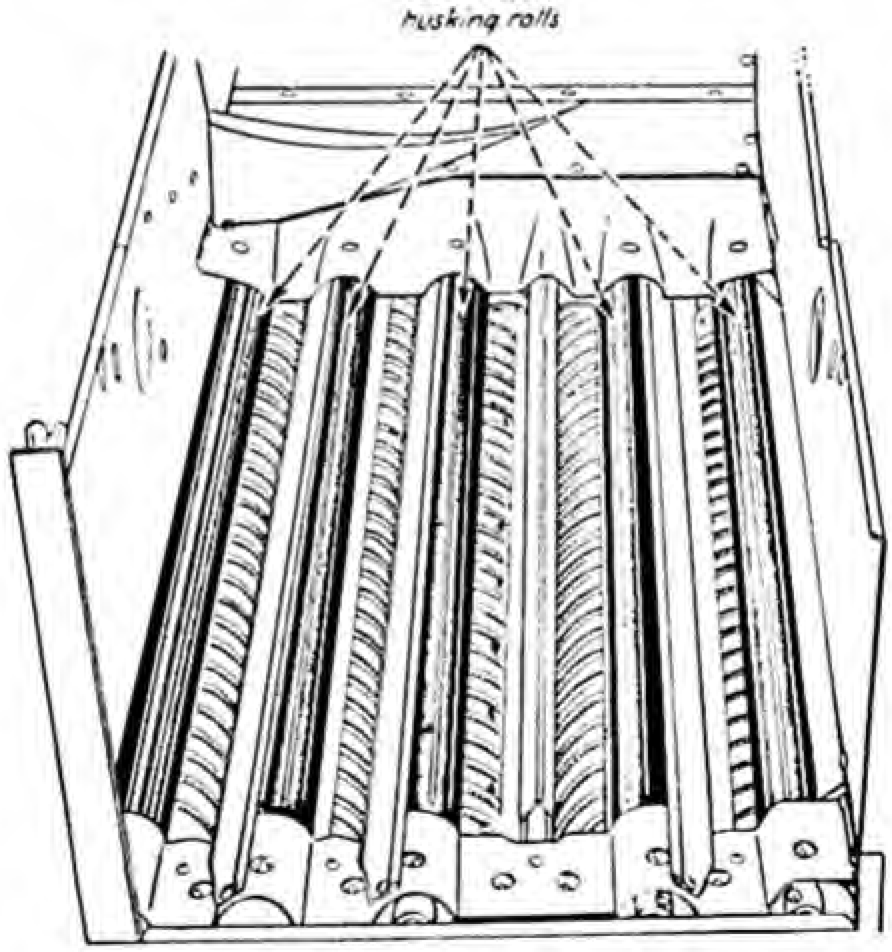


FIG. 506.—Husking rolls for corn pickers.

removed from the stalks by the snapping rollers. It is then elevated and dropped into the shelling unit, which consists of a cylinder-type sheller. There are sieves and a fan for cleaning the shelled corn, which is elevated and delivered to a grain tank.

441. Harvesting Costs.—The three following tables on the cost of harvesting and cribbing corn are reproduced from Indiana Agricultural Experiment Station Bulletin 362.

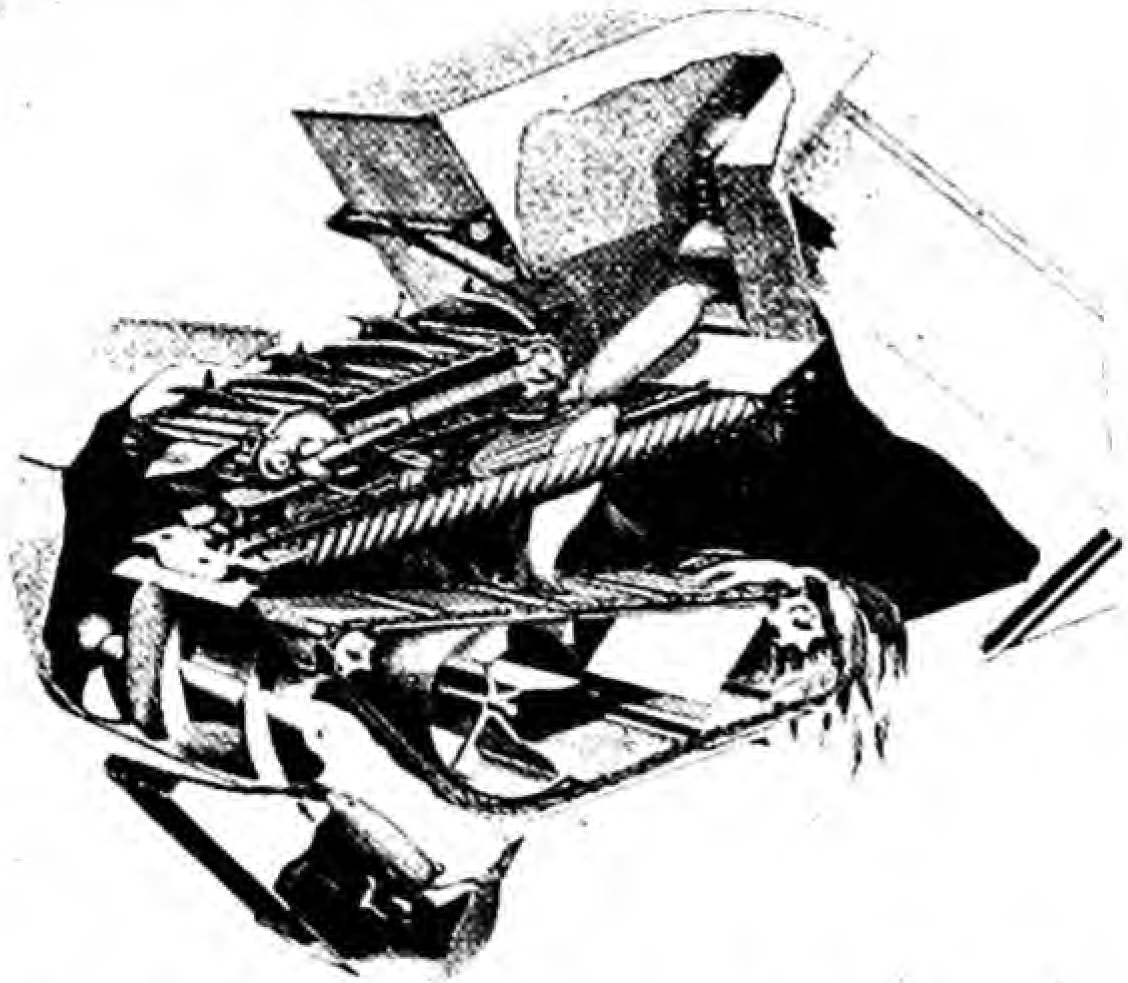


FIG. 507.—Cross-sectional view of husking unit for a corn picker.

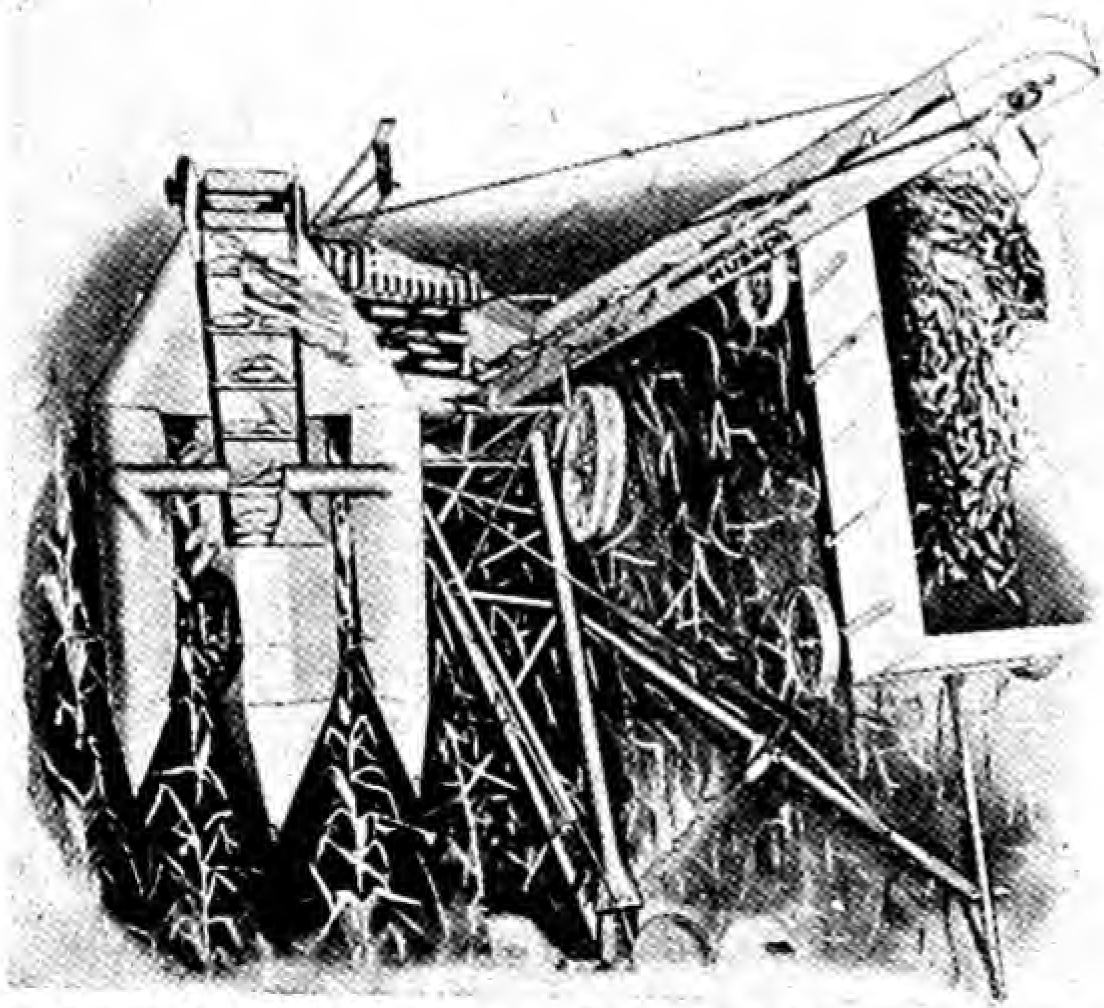


FIG. 508.—Showing path traveled by ears of corn as they pass from the snapping rolls up the elevator, across the husker, up the wagon elevator, and into the wagon.

"The yield per acre was one of the most important factors which affected the cost of husking a bushel of corn with mechanical pickers. Yields had little effect on the amounts of time and materials required to

TABLE XIV.—COSTS OF HUSKING AND CRIBBING CORN BY THREE METHODS, 1929, 1930, AND 1931

Method	Dollars per acre			Cents per bushel		
	1929	1930	1931	1929	1930	1931
Hand husking	3.98	3.62	2.97	10.0	8.7	6.1
One-row pickers	3.41	3.15	3.09	8.8	8.1	6.0
Two-row pickers	2.42	2.29	2.39	5.9	5.4	5.0

TABLE XV.—LABOR, POWER, AND MACHINERY REQUIREMENTS FOR HUSKING AND CRIBBING AN ACRE OF CORN BY THREE METHODS, 1929, 1930, AND 1931

Method	Man labor, hours	Horse work, hours	Wagon use, hours	Tractor use, hours	Picker use, hours
Hand husking	5.35	10.79	5.26		
One-row picker	2.98	3.60	2.57	1.20*	1.19*
Two-row picker	2.10	2.67	1.82	.72*	.71*

* Differences between the figures for tractor and for picker use were caused by two men using two tractors, one pulling the picker and the other drawing the loaded wagons to the crib.

TABLE XVI.—YIELD PER ACRE AND CORN-PICKING COSTS, 1929, 1930, AND 1931

Yield group	Average yield, bushels	Man-hours per acre	Bushels picked per man-hour	Cost per acre	Cost per bushel
One-row pickers					
Farms with lowest yields	38	2.89	13.2	$3.16	8.5¢
Farms with highest yields	50	3.10	16.1	$3.28	6.7¢
Two-row pickers					
Farms with lowest yields	35	1.90	18.7	$2.21	6.3¢
Farms with average yields	44	1.93	22.9	$2.43	5.5¢
Farms with highest yields	54	2.05	26.4	$2.49	4.6¢

pick an acre, and costs per acre were but slightly higher on the farms which had high yields of corn. Costs per bushel were much lower when high yields were secured.

"Hand husking was usually hired on a bushel basis and high yields were associated with proportionally higher costs per acre, with costs per bushel remaining practically unchanged."[1]

[1] *Ind. Agr. Expt. Sta. Bull.* 362, p. 8, 1932.

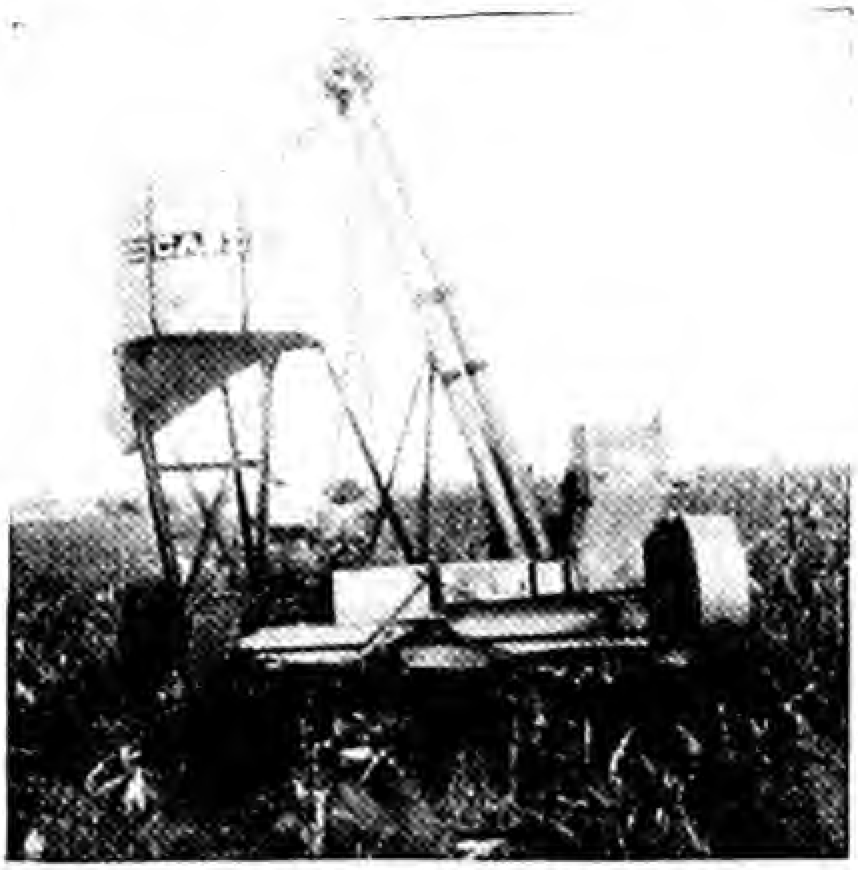


FIG. 509.—Rear view of two-row pull-type corn picker equipped with shelling unit and grain tank.

442. Factors Affecting Performance of Corn Pickers.—There are a number of factors that will influence the performance or efficiency of corn pickers. Several are listed as follows:

1. Plant characteristics.
   a. Variety or hybrid suitable for machine harvesting.
   b. Stiff stalks that stand up and do not break over and lodge.
   c. Condition of the stalks.
   d. Height of ears and stalks.
   e. Toughness of the ear shanks.
   f. Size of ears—large ears reduce shelling losses.
   g. Hard shelling characteristics reduce shelling losses.
   h. Thick and tight husk on ear desirable for snapping but not for husking.
2. Mechanical factors.
   a. Type of snapping roll surface.
   b. Adjustment of snapping rollers—distance apart.
   c. Timing of snapping rollers.
   d. Rate of travel.
   e. Type of wagon hitch.
   f. Adjustment of dividers to pick up down stalks.
3. Miscellaneous factors.
   a. Timeliness of harvest. Less field loss if harvesting is done early.
   b. Carefulness of operator.
   c. Weather conditions.
   d. Cleanliness of fields from tall weeds and grass.
   e. Length of rows.
   f. Row spacing suitable for machine.

CHAPTER XXIII

COTTON-HARVESTING MACHINERY AND GINS

COTTON HARVESTERS

Heretofore, in referring to developments in the mechanical harvesting of cotton, hopes have been expressed that an economical, successful, cotton-harvesting machine would soon be perfected. Now, however, it can be said that at least two types of cotton-harvesting machines are in use by cotton growers. These types are the cotton stripper and the cotton picker.

THE COTTON STRIPPER

The stripper-type cotton harvester removes by a stripping process the whole boll of cotton—both the cotton and the bur. The separation of the cotton from the bur is accomplished by running the stripped cotton through a machine called an *extractor*, because it extracts the seed cotton from the bur.

The earliest type of cotton stripper used by cotton growers was called a *sled stripper* because it consisted of a sledlike box, on the front end of which were fastened comblike teeth. These teeth, in fact, actually combed the cotton from the plants. An excessive amount of foreign matter was collected with the cotton, and the field losses were high. Therefore, the farmer only used this stripper when labor was not available to harvest the crop.

At present there are three types of commercial two-row tractor-mounted cotton strippers. They may be classified as the double-roller, the single-roller, and the combing tooth.

443. The Double-roller Stripper.—A successful tractor-mounted double-roller stripper was developed by the Texas Agricultural Experiment Station in 1930. Commercial interest in this development began in 1943, and the two-row tractor-mounted machine shown in Fig. 510 uses the stripping principles developed by the Texas Agricultural Experiment Station. The stripper units consist of two parallel-mounted smooth revolving rollers. The adjacent sides of the rollers, between which the plant passes, move upward; as the bolls are snapped off, the surface friction of the rollers moves the cotton away from the plant and transfers it into screw-type conveyors located on each side (Fig. 510). As the

cotton leaves the conveying augers it is dropped upon a right and left cross-auger conveyor which delivers the stripped cotton to the centrally located trailer elevator. This elevator conveys the cotton up and drops it into a trailer drawn behind the machine.

FIG. 510.—Front view of two-row tractor-mounted double-roller cotton stripper.

444. The Single-roller Stripper.—The stripping mechanism of the two-row tractor-mounted cotton stripper shown in Fig. 511 consists of a single lightly fluted roller operating in conjunction with an adjustable stripper bar. As the bolls are stripped from the plant by the revolving roller they are carried to a side conveyor. The bolls are then delivered by pin wheels to a right and left screw-type cross-conveyor, which delivers the cotton to a centrally located trailer elevator. Pick-up or

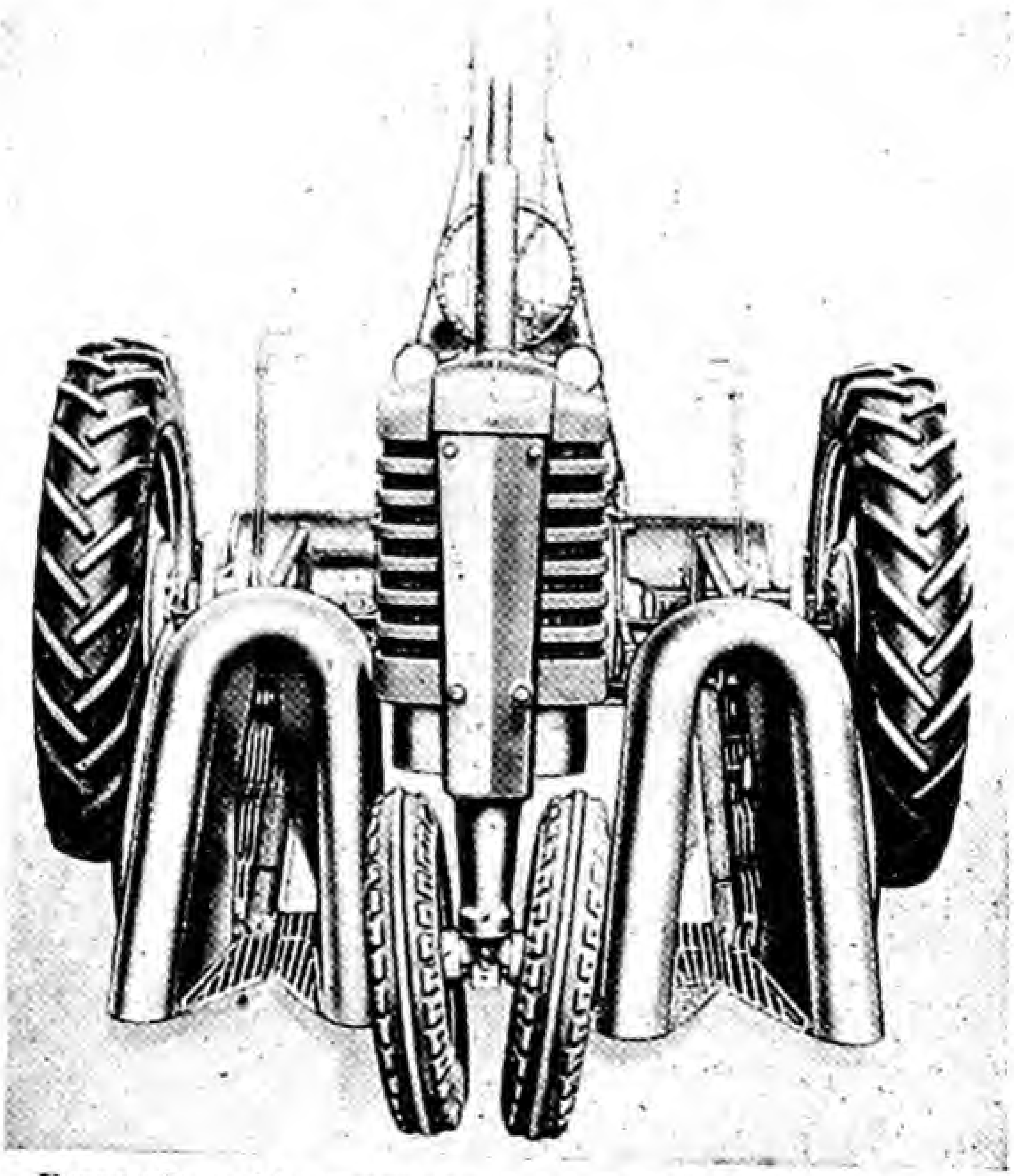


FIG. 511.—Front view of two-row tractor-mounted single-roller cotton stripper.

limb-lifting fingers (Fig. 512) are provided to lift low limbs and guide them into the stripping unit.

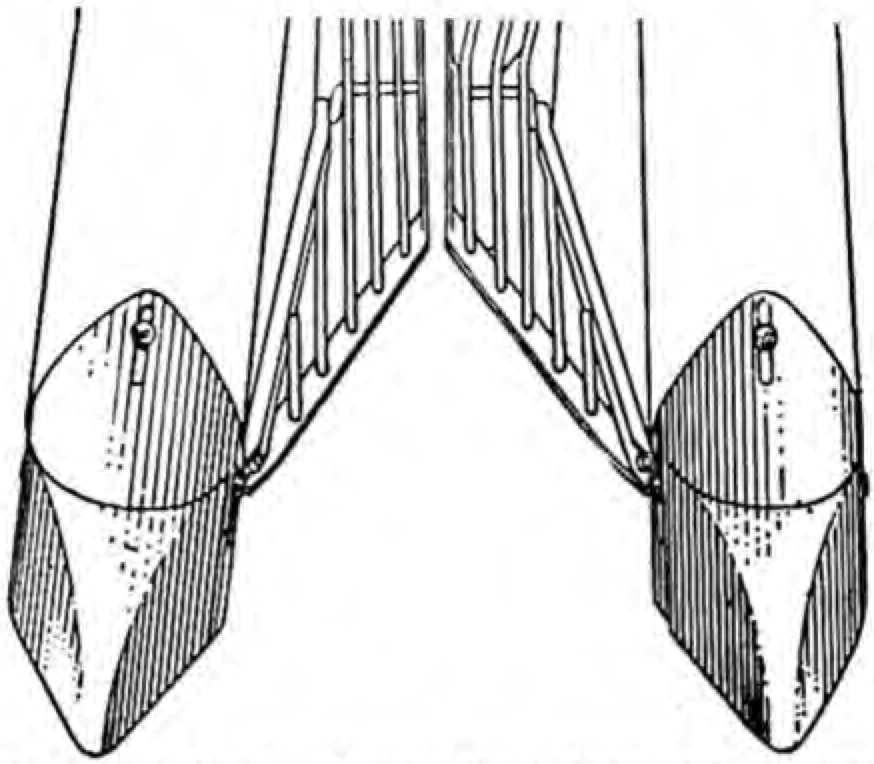


FIG. 512.—Limb-lifting fingers for cotton-stripping machines.

445. The Comb or Finger Stripper.—The two-row tractor-mounted cotton stripper shown in Fig. 513 is equipped with fingers such as are used on the finger-type homemade sled stripper. The tractor-mounted stripper combing fingers are made of 1-inch-leg angle-iron sections about 20 inches long. The rear ends of the sections are welded to a heavy bar with the valley of the angle iron up and spaced so the edges of adjacent teeth are about ¾ inch apart. The front ends of the angle iron or teeth

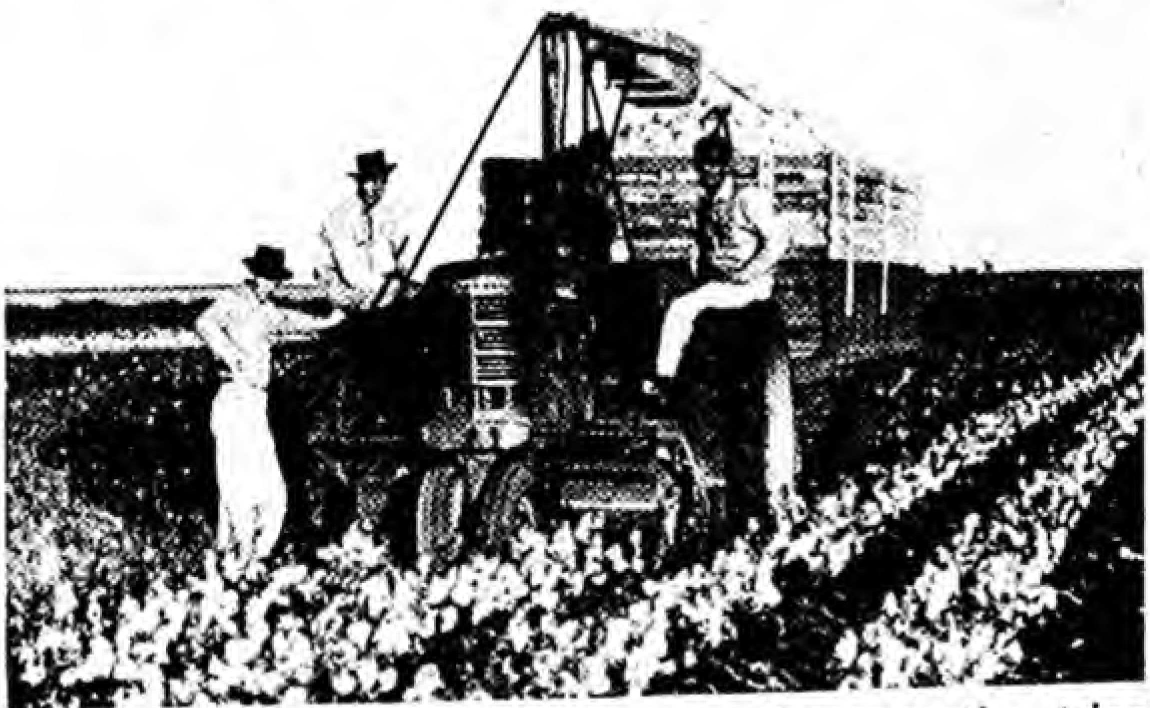


FIG. 513.—Two-row tractor-mounted stripper using fingers as the stripping unit and a paddle wheel to sweep the cotton back into the air conveyor.

are hammered together and bent slightly upward. Just above the rear part of the stripper fingers is located a revolving wheel equipped with a rubber belt or metal fingers to sweep the cotton off the stripping fingers into the conveying system.

446. Use of the Stripper-type Cotton Harvester.—Generally, the stripper-type cotton harvester is best suited to low-growing, short-limbed

plants. When the plants are large it is difficult to remove the cotton from the plants by compressing and pulling them between the closely spaced stripping units without an excessive amount of the cotton passing downward with the plants and being lost on the ground. If stripping is done before a freeze kills the foliage and causes unopened bolls to dry, excessive amounts of green foliage and the unopened bolls will be collected with the cotton. Such material cannot be ginned until it has been thoroughly dried. A chemical dust can be used to defoliate and rid the plants of green foliage before a freeze, but this does not dispose of all the green bolls.

The Cotton Picker

The picker-type cotton harvester picks the mature seed cotton out of the boll. The empty bur is left on the plant the same as when picking is done by hand.

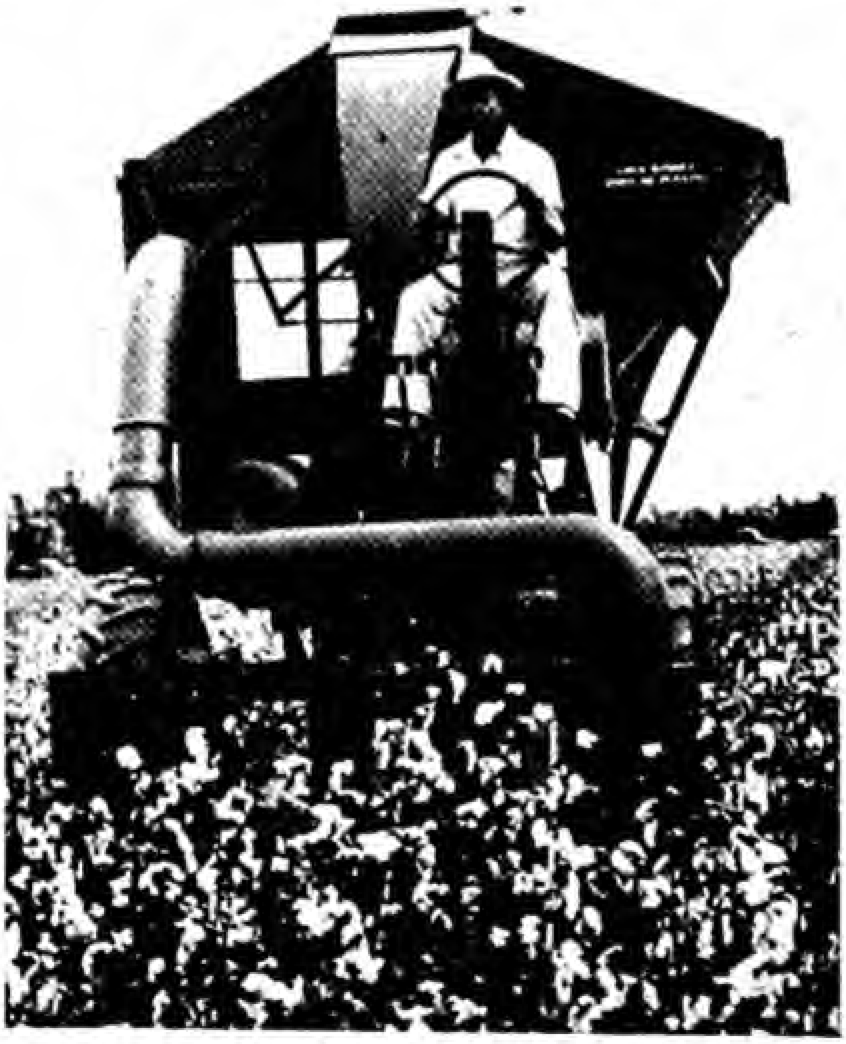


Fig. 514.—Single-row tractor-mounted cotton picker picking cotton in well-defoliated cotton.

Even though there are several farm-machinery manufacturing concerns testing experimental models, only one company is at present offering a mechanical cotton-picking machine for sale.

This is a one-row spindle-type machine, having two picker units arranged so the spindles project into the plants and pick cotton from both sides. The picking unit is mounted on the rear of a general-purpose row-crop tractor (Fig. 514). The tractor travels backward at the regular tractor speeds. The picking speed is about 2 m.p.h.

447. Operation of Cotton Picker.—The picking element of the machine consists of a sturdy steel box, housing two picker drums, each arranged with fifteen cam-actuated picker bars (Fig. 516) containing twenty picker spindles per bar,

FIG. 515.—Experimental two-row tractor-mounted cotton picker.

or a total of 600 picking spindles. These spindles are all driven by individual gears enclosed in the picker bars. The picking spindles are spaced so as to pick a high percentage of the open cotton but permit room for the green unopened bolls to remain on the plants. The speed of the drum rotation is timed in rela-

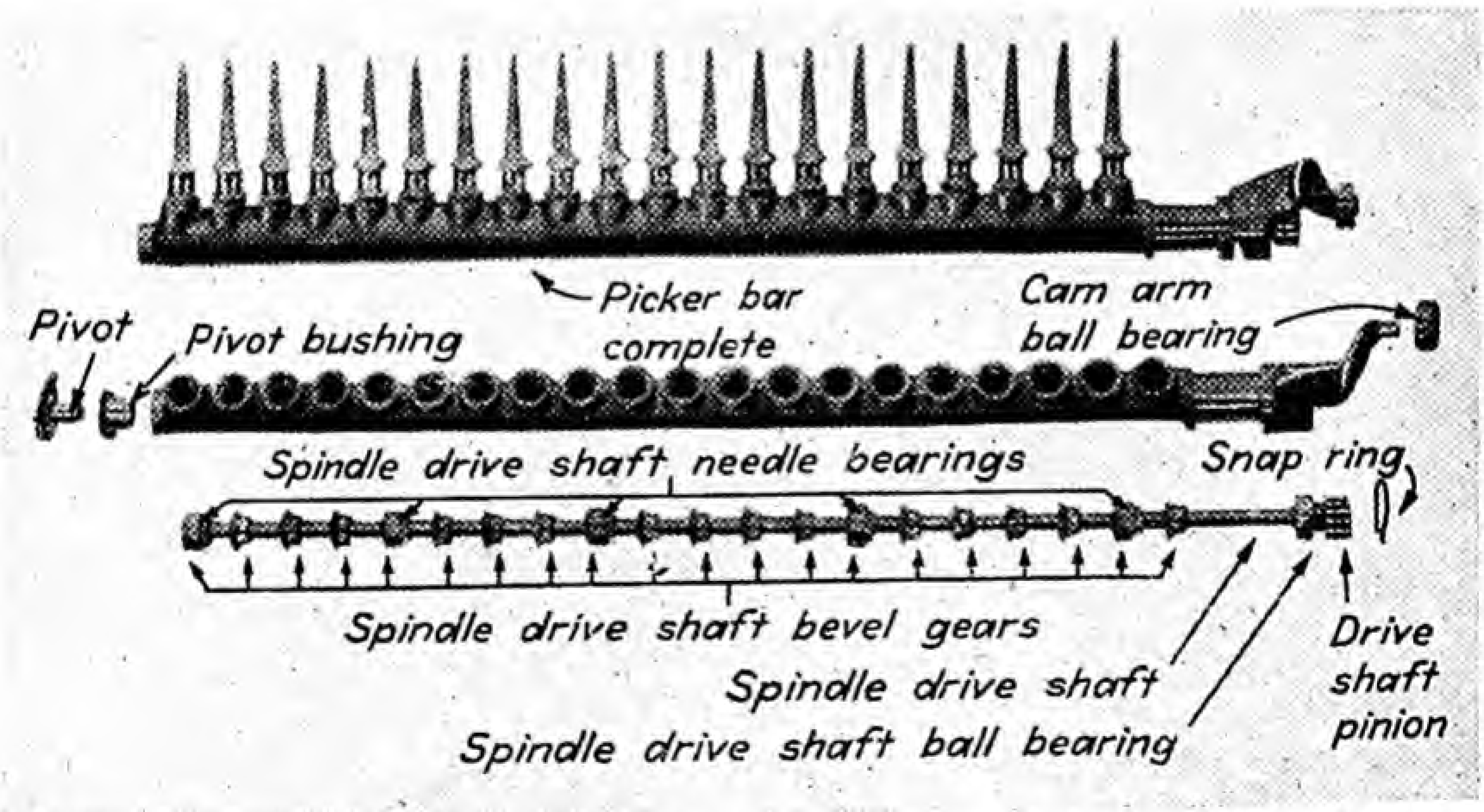


FIG. 516.—Picking bar complete with spindles and gear shaft removed from bar.

tion to the tractor speed, so that the plants pass through the throat of the machine without damage to the green bolls or plants.

A spindle-moistening system is incorporated into the picking unit as an aid in keeping the spindles clean (Fig. 517). A film of water is applied by means of

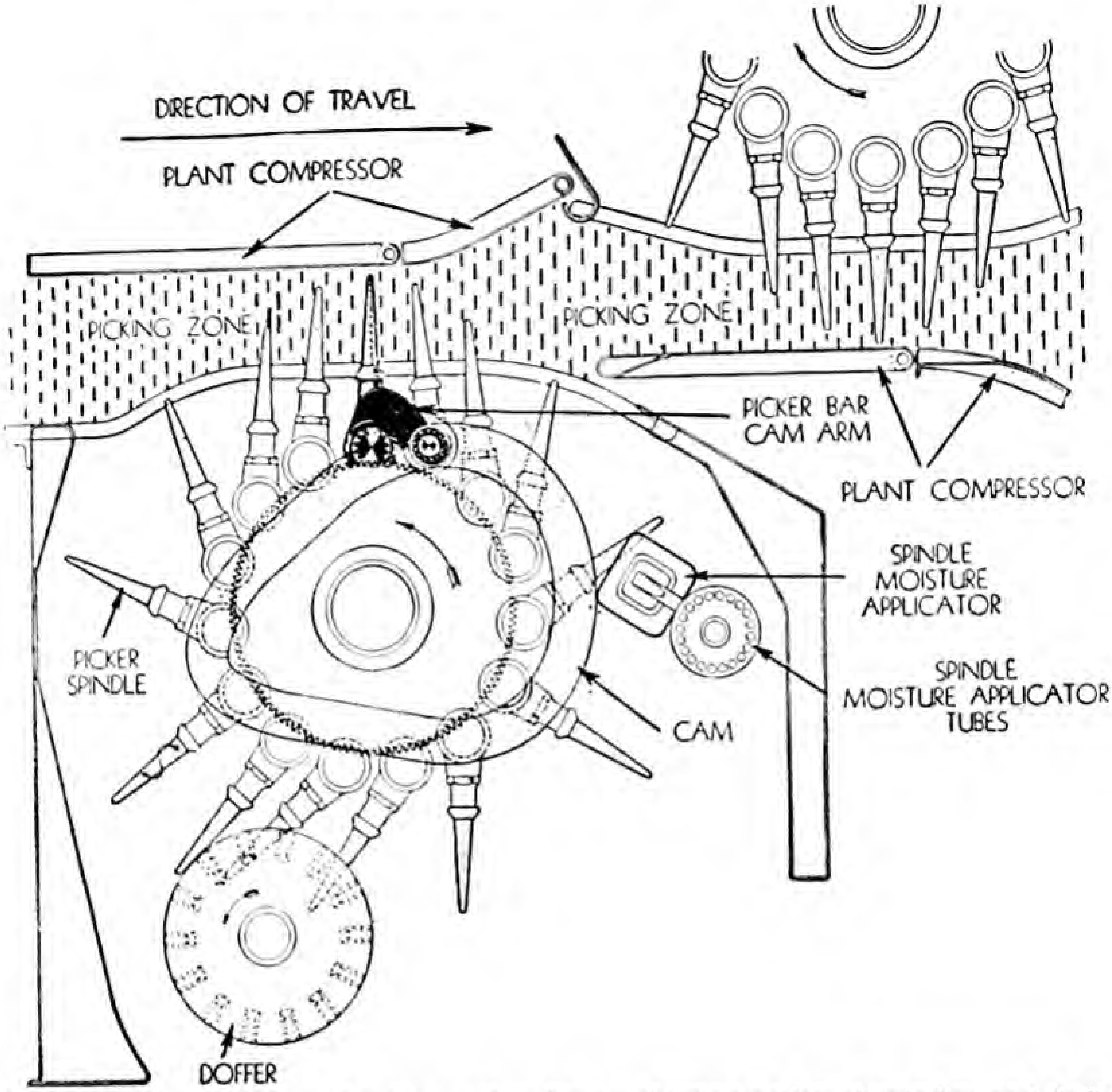


FIG. 517.—Sectional view of cotton-picker drums, showing action of spindles and doffer.

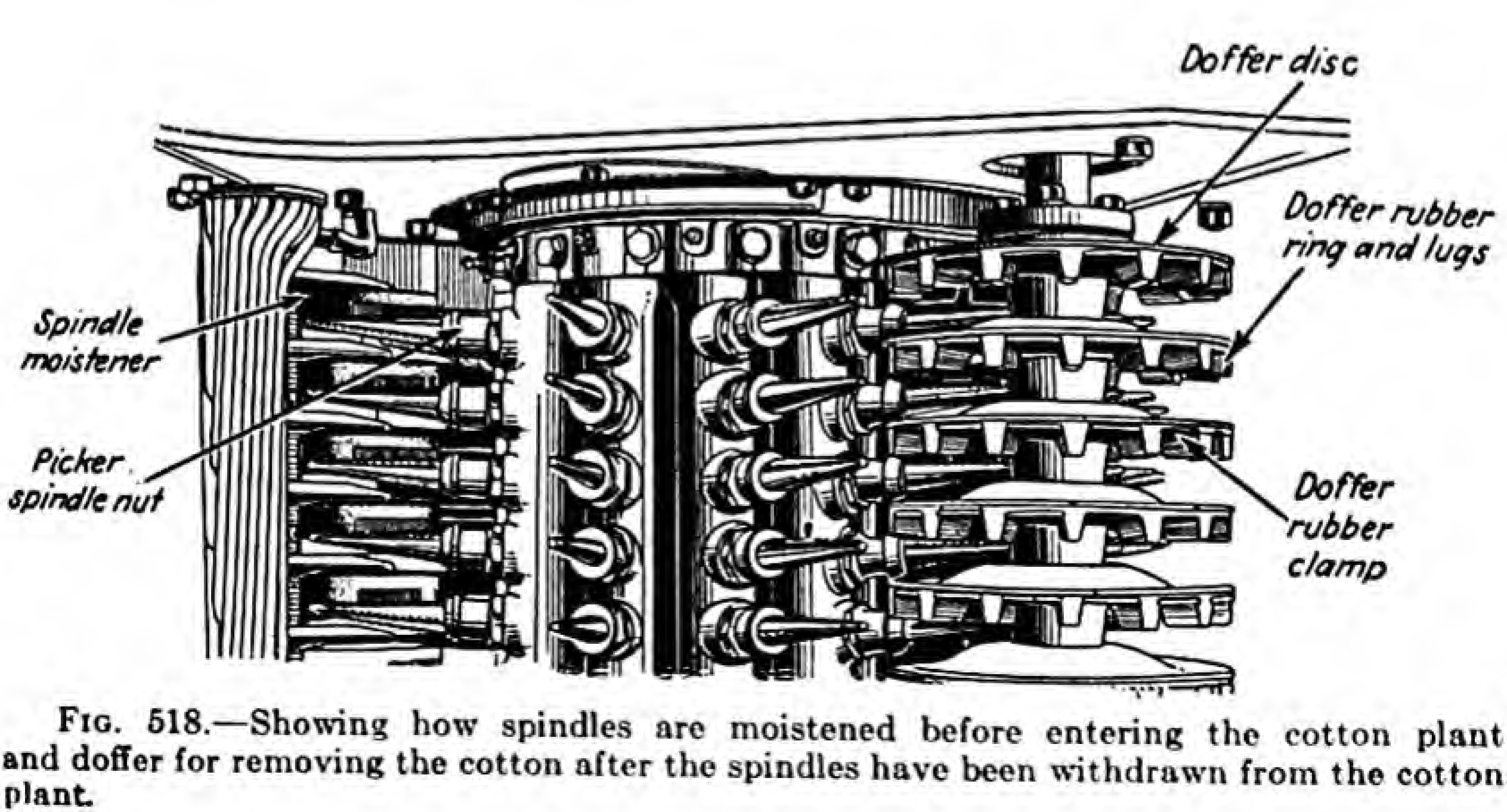


FIG. 518.—Showing how spindles are moistened before entering the cotton plant and doffer for removing the cotton after the spindles have been withdrawn from the cotton plant.

rubber applicators directly to each spindle just before it penetrates the plants to gather the cotton. The system consists of a water tank, a water pump, and two metering devices with two sets of water applicators and their supports.

The water passes from the tank to the water pump located on and driven from the picker transmission housing. The pump delivers water under pressure to the metering devices, which distribute equal amounts to the individual applicators. Small control valves with dial-type indicators serve to control the supply of water fed to the applicators.

As the spindles enter the plant, they extract the cotton from the open bolls and carry it into the interior of the picker drum box, where it is removed by the

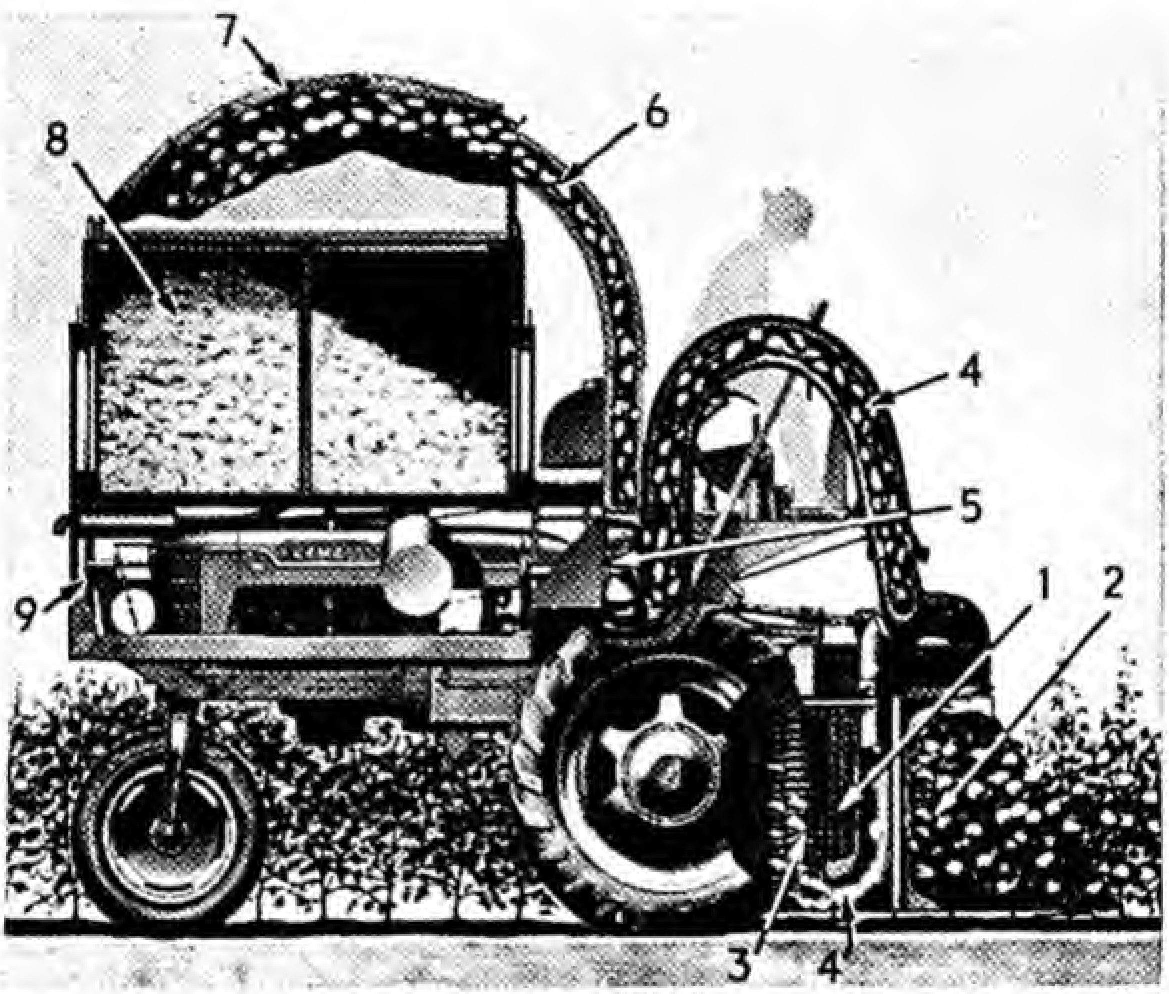


FIG. 519.—How the cotton picker works. In the revolving picker drums (1 and 2) are the rotating barbed spindles that pick the cotton from each side of the plant. Rubber doffers (3) remove the cotton from the spindles. The cotton drops to the air conveyor inlet (4). Moisture applicators (not shown) moisten the spindles before they enter the plant to aid in picking and doffing the cotton. The vacuum conveyor system (4) draws the cotton from the air conveyor inlet to the fan (5). From the fan (5) the cotton is blown into the air-blast conveyor system (6). Cotton is blown against grates (7) at the roof of the basket (8). The air passes through the grates and carries dirt and trash with it. The cotton drops to the bottom of the basket. Two hydraulic cylinders (9) raise the basket for dumping the cotton into a wagon or truck.

doffers and dropped at the entrance of the air conveyor system located in the bottom of the drum-box doors (Fig. 519).

The cotton is elevated by air and blown into the large basket located above the tractor (Fig. 519). The basket can be completely filled with little attention from the operator. The unloading of the filled basket is accomplished by means of the hydraulic lift. Only one man is necessary for the operation of the cotton picker.

448. Defoliation of Cotton Plants.—The defoliation of cotton with a chemical dust, in which calcium cyanamid is the active ingredient, has

been used in connection with the mechanical harvesting of cotton with considerable success. The defoliant is applied at the rate of 20 to 30 pounds per acre, when most of the bolls are mature or when only a few are younger than 30 days. The fiber in a cotton boll 21 days old has usually reached its mature length. Therefore, when the foliage drops off

Fig. 520.—Aerial view of defoliated field of cotton being mechanically picked. September 20, in central south Texas.

the plant, sunshine causes the bolls to open, and harvesting can begin much earlier than when plants are not defoliated. Farmers find that by defoliating cotton fields which are to be picked by hand they can get a higher percentage of the crop at one time, and, too, labor can see the bolls easier and pick more pounds of cotton. Heavy foliage on the plants

Fig. 521.—Applying defoliant to field of cotton with airplane.

makes it difficult to see all the bolls readily. The defoliant should be applied when there is a heavy dew and when there is a high relative humidity of the air. Figure 521 shows a chemical dust defoliant being applied to a cotton field by airplane. Figure 522 shows a well-defoliated cotton field.

FIG. 522.—A well-defoliated field of cotton.

449. Varietal Characteristics Affect Efficiency of Mechanical Cotton Harvesters.—Until a few years ago all the efforts of engineers were directed toward making a cotton harvester that would do a good job of harvesting cotton in any field regardless of the variety of cotton grown. Little or no thought was given to what effect the varietal characteristics would have on the performance of the machine. Consequently, it was found that machines did well in some fields and poorly in others. Since attention has been given to the varietal effect on the performance of

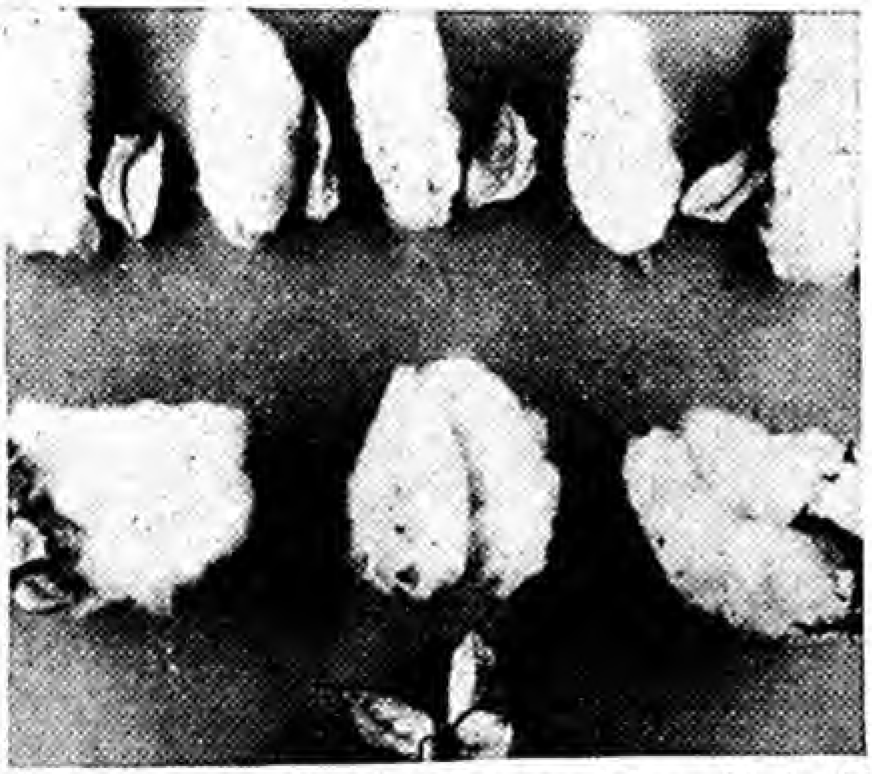


FIG. 523.—Typical variety of cotton that is easy to pick and is lacking in storm resistance.

mechanical cotton harvesters, it has been found that some varieties are more suited to the picker-type harvester and others better suited to the stripper-type harvester. Varieties suitable for the mechanical picker should have well-opened bolls, storm resistance, fluffy locks, and a staple of sufficient length to wrap around the picker spindles (Fig. 523). Varieties suitable for the stripper-type harvester have almost the opposite characteristics. That is, the bolls should not spread open too wide, and the locks should be fairly tight in the bur (Fig. 524) and not so fluffy that they will catch and hang to parts of the plant as it passes through the stripping mechanism.

FIG. 524.—Extra-stormproof type of cotton that is extremely hard to remove from the boll. Note how the cotton fibers adhere to the bur.

450. Cost of Harvesting Cotton.—It requires 1,200 to 1,500 pounds of hand-picked seed cotton to produce a 500-pound bale of lint cotton; the average price paid for the picking of 100 pounds of seed cotton will vary with the price of lint cotton and the general economic condition of the country. In times of depression and low values the price may be 50 to 60 cents per 100 pounds of seed cotton, while in years of peak prices the price may be $1.50 to $2.00 per 100 pounds. Therefore, the differential saving in harvesting costs between hand and machine methods will vary. An average of 1,850 pounds of hand-snapped and machine-stripped cotton is required to produce a 500-pound bale of lint cotton. At $1.50 per hundred for harvesting by hand-snapping, the cost per bale will be $27.75. If hauling and ginning charges are included, the cost is approximately $39.00. If all costs and charges are considered, the average cost to machine strip a bale is approximately $17.00. This gives a saving of around $22.00 per bale in favor of machine stripping. Similar savings are noted when the hand-picking and machine-picking methods are compared. The number of 500-pound bales of lint cotton harvested with any type of mechanical harvester will vary directly with the yield, or the amount of cotton available for the machine to harvest. The cost, of course, will vary correspondingly.

451. Factors Affecting Performance of Mechanical Cotton Harvesters. The factors affecting the efficiency of mechanical cotton harvesters may be classified as follows: Plant characteristics, mechanical factors, cultural methods, and miscellaneous factors.

1. Plant characteristics.
   a. Shape of plant.
   b. Height of plant.
   c. Length of branches.
   d. Number of branches.
   e. Density of foliage.

   f. Type of boll.
   g. Bolls borne singly or in clusters.
   h. Storm resistance.
   i. Degree of boll spread.
   j. Fluffiness of the cotton.
   k. Brittleness of branches and boll peduncles.
   l. Height of first branches above ground.
2. Mechanical factors.
   a. Type of pickup fingers.
   b. Type of stripping mechanism.
   c. Type of picking spindles.
   d. Rate of travel.
   e. Type of elevating equipment.
3. Cultural methods.
   a. Last cultivation should leave a slight ridge at base of plants.
   b. Spacing of plants along row.
   c. Row spacing to suit machine.
   d. Field layout—length of rows.
4. Miscellaneous factors.
   a. Skill and carefulness of operator.
   b. Timeliness of harvest.
   c. Freedom of field from weeds, vines, grass, and stumps.
   d. Topography of land.

THE COTTON GIN

The most important operation in the production and preparation of cotton for the market is the separation of the lint from the seed, a process known as *ginning*.

FIG. 525.—Negroes picking lint from cottonseed before the invention of the cotton gin.

The history of the practical cultivation of cotton in America dates from 1621, when it was introduced into what is now the state of Virginia,

with seed from the East Indies. At that time the lint was picked from the seed by hand, as shown in Fig. 525.

The first known mechanical means of separating the seed from the lint is shown in Fig. 526. This primitive device would handle sea-island or long-staple cotton but was practically useless when applied to short-staple cotton.

Consequently, Eli Whitney's invention of the saw gin, a model of which is shown in Fig. 527, proved to be an epochal event. The patent was issued to Eli Whitney on Mar. 14, 1794, signed by George Washing-

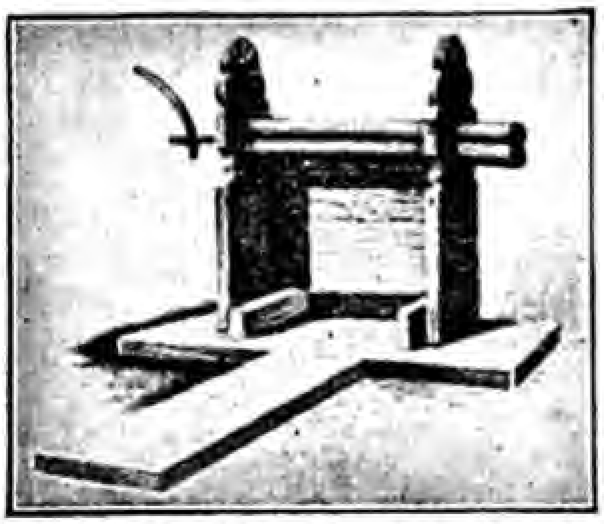


FIG. 526.—The Churka, the first known cotton gin.

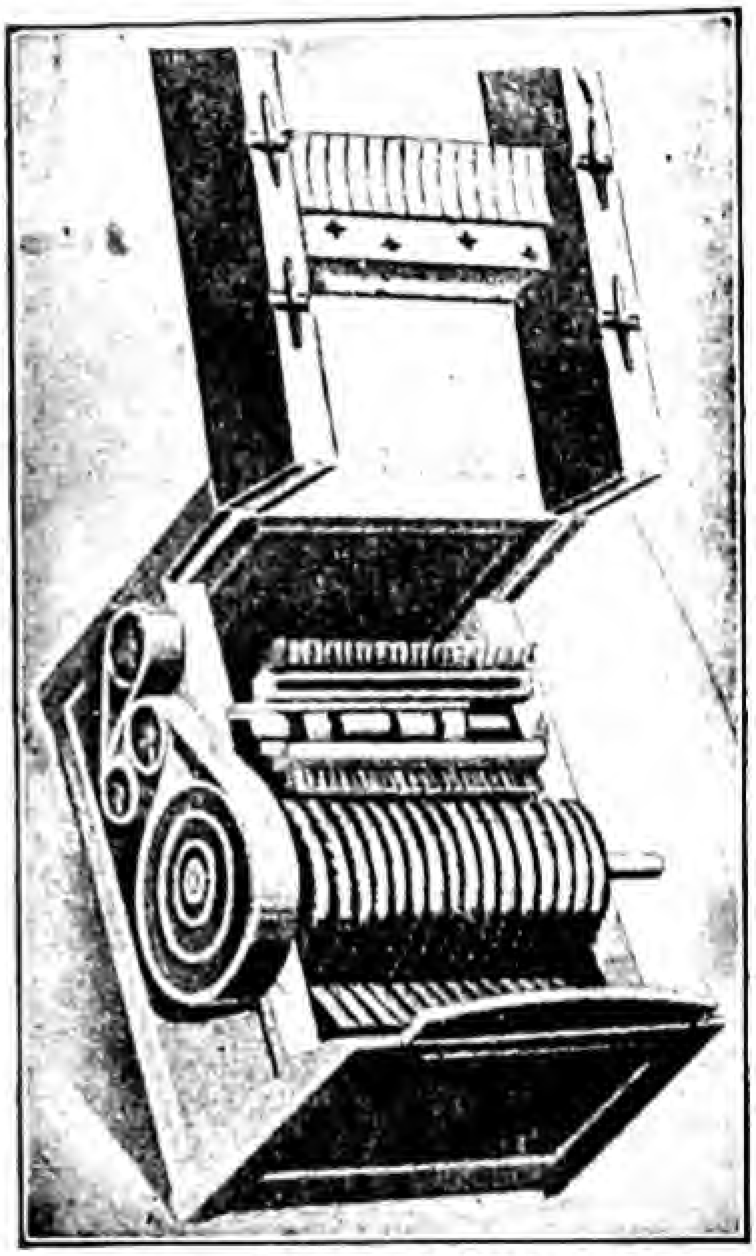


FIG. 527.—Model of Whitney's first saw gin.

ton, President; Edmund Randolph, Secretary of State; and William Bradford, Attorney General.

452. Gin Types.—There are two types of gins, the roller and the saw. The former is not extensively used, while the latter is practically a universal type.

THE ROLLER GIN

Figure 528 shows the working parts of a roller gin. The lint is pulled from the seed by a walrus-hide-covered roller *B* assisted by the fixed knife *D* and a moving knife *F*.

A roller gin has a very small capacity, about 1 bale in 10 hours.

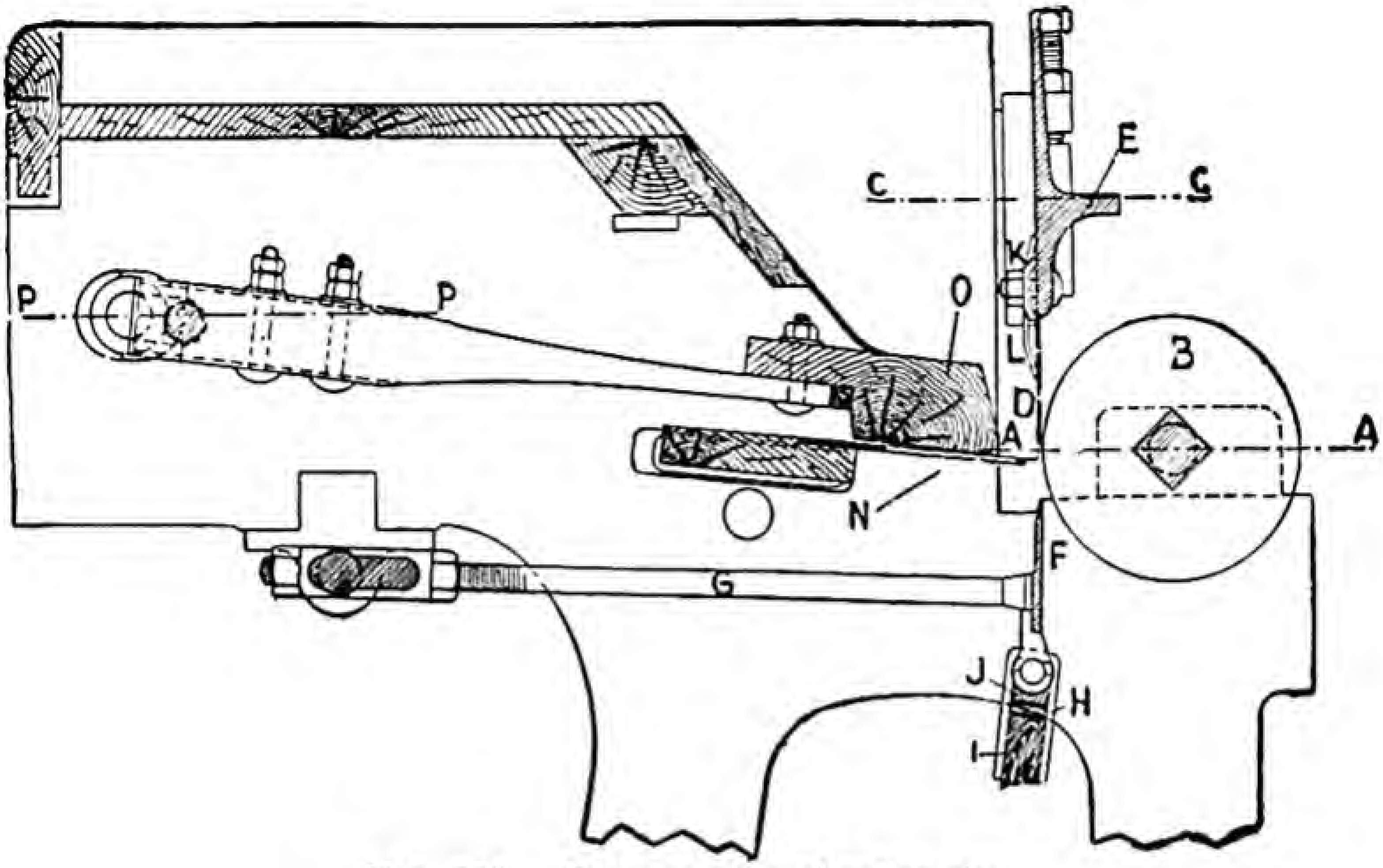


FIG. 528.—Cross section of roller gin.

THE SAW GIN

Some of the large custom ginning plants of today often require an investment of $60,000 or $90,000. During a good crop year such a plant may gin as many as 5,000 bales of 500 pounds each. The small plantation gin, which may not gin more than 200 bales per season, does not require such a large investment.

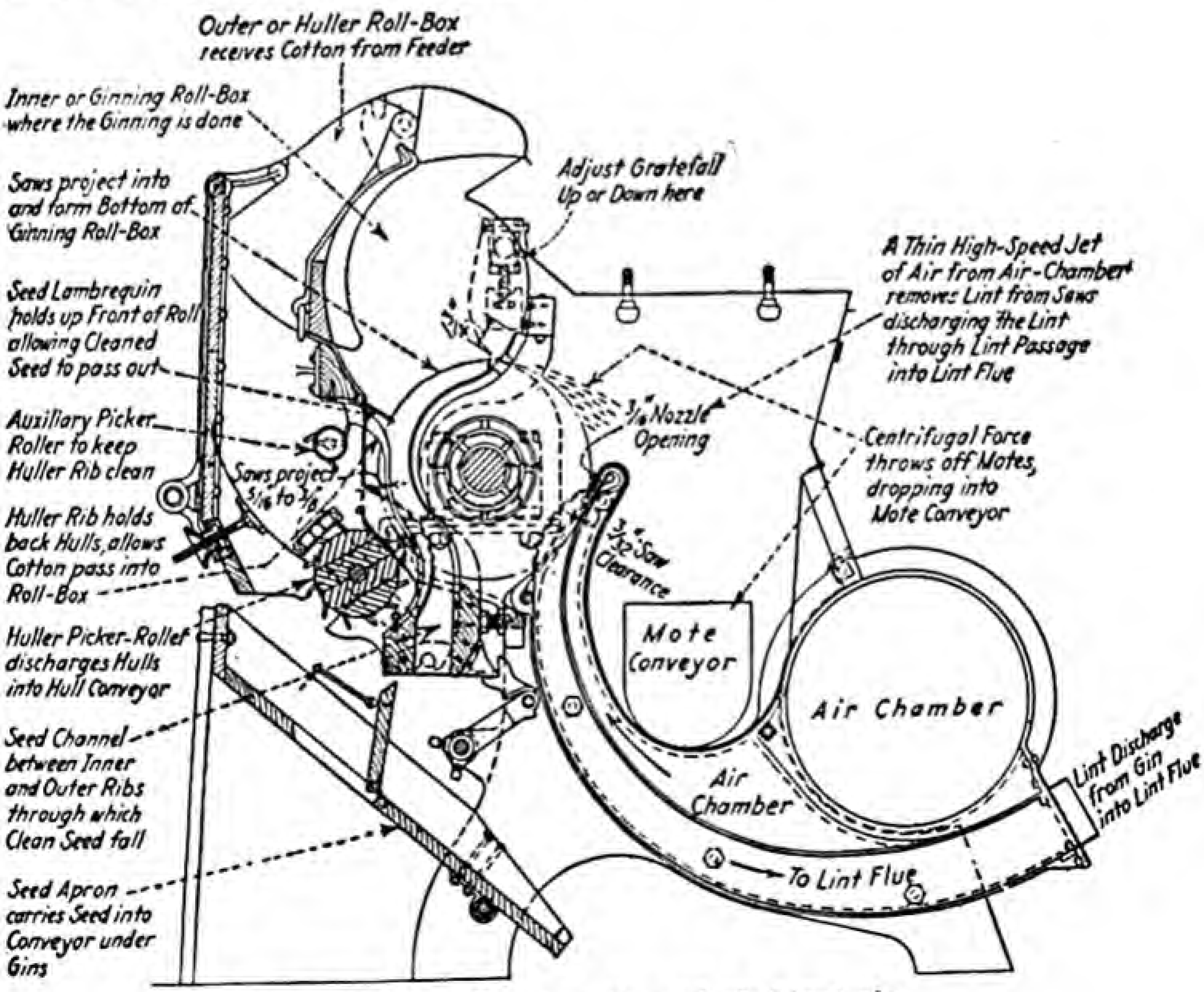


FIG. 529.—Cross section of air-blast gin.

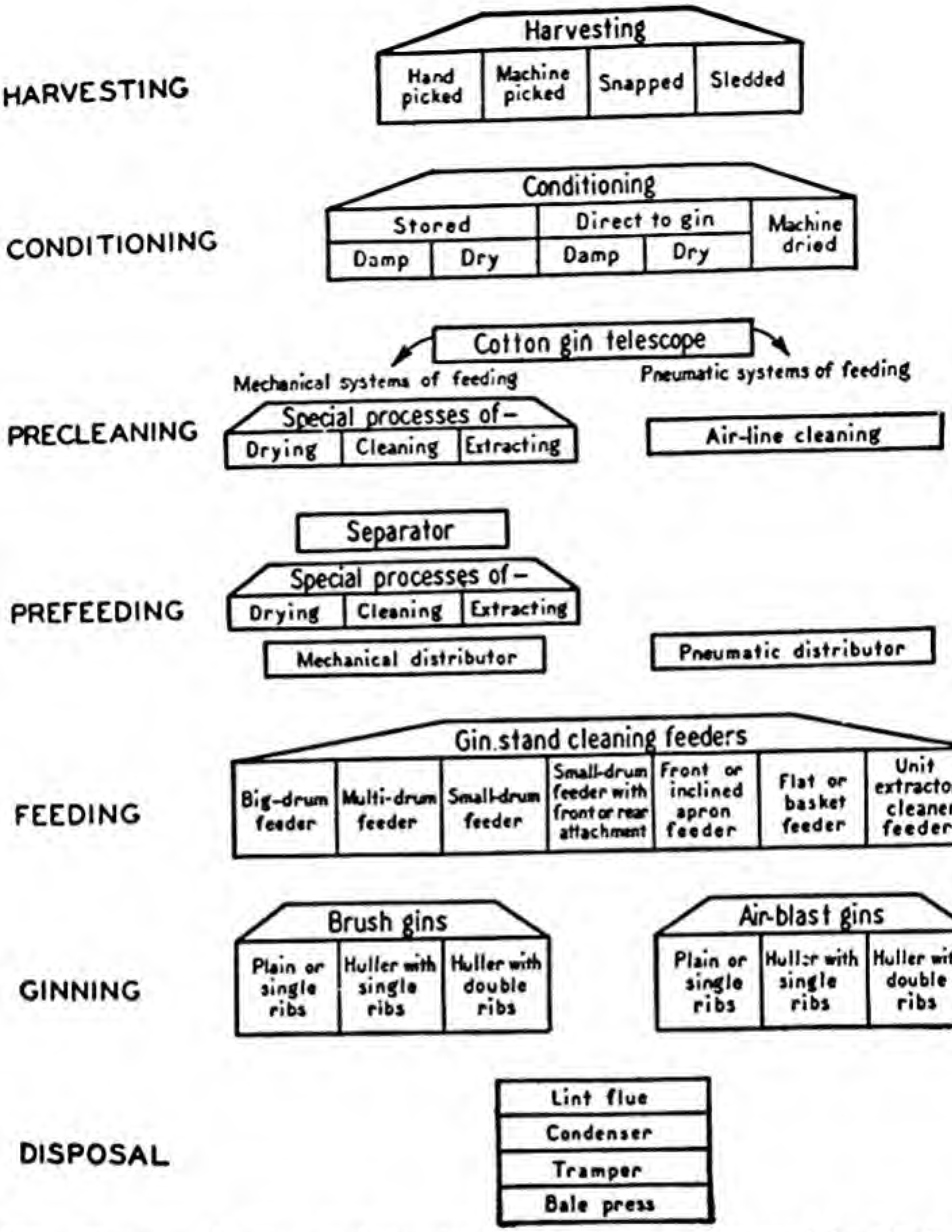


FIG. 530.—Diagram showing various steps and processes involved in ginning cotton. (*U. S. Dept. Agr. Farmers' Bull.* 1748.)

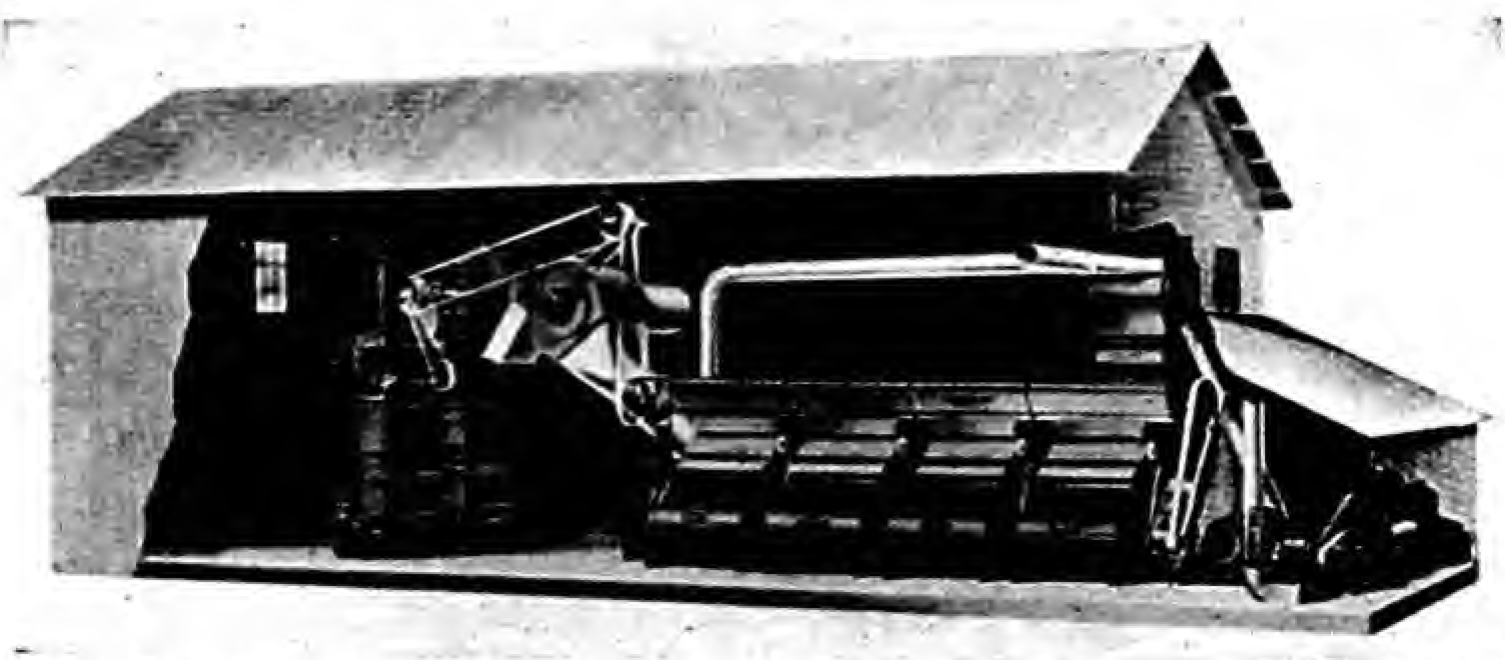


FIG. 531.—One-story electrically operated gin showing mechanical distributor and down press.

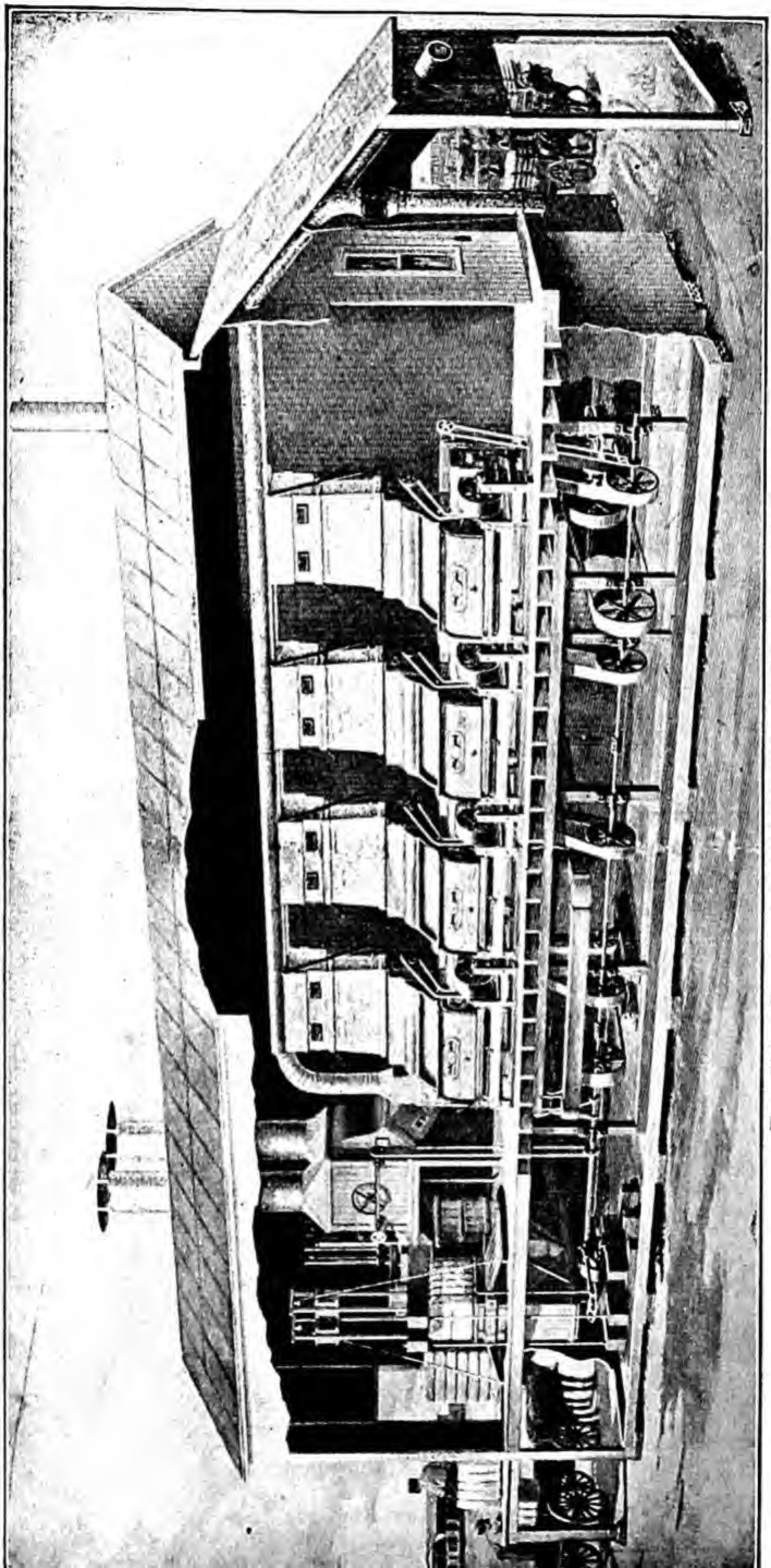


FIG. 532.—Two-story gin with pneumatic elevator distributor.

453. Gin Outfits.—In general, there are two methods of installing gin outfits. These are a one-story construction, as shown in Fig. 531, and a two-story system, shown in Fig. 532. There are many arguments for and against each method of installation, but it appears that the one-story outfit is the more commonly used. It is obvious that a gin installed on the ground will give less vibration, resulting in less wear and deterioration of the machinery. When placed on a concrete floor, the fire risk is less, which in turn lowers the cost of insurance.

The operation of a cotton gin requires a trained man who knows how to make the many intricate adjustments so that high-quality cotton is produced. For this reason the construction and operation of the various units that compose a complete modern cotton gin will not be discussed in detail.

CHAPTER XXIV

SPECIAL ROW-CROP HARVESTERS

Several row crops such as potatoes, beets, peanuts, and sugar cane require harvesting machinery designed especially to suit the crop. Such crops are grown in smaller regional areas than corn, cotton, and the small grains. Crops such as potatoes, beets, and peanuts must be removed from the ground. Other crops are borne on plants above the ground.

POTATO DIGGERS

Potato diggers may be divided into two classes according to power requirements, horse-drawn and tractor-operated. There are two types of horse-drawn potato diggers, which are called the walking and the riding type with elevator. Tractor-operated potato diggers can be classed as single- and double-row tractor power-take-off-driven and tractor-drawn types. Again, there are types designed as level-bed diggers and as angle-bed diggers.

HORSE-DRAWN POTATO DIGGERS

454. Horse-drawn Walking Potato Diggers.—The simple walking potato digger shown in Fig. 533 has a round pointed scoop blade back of which is a shaker grate.

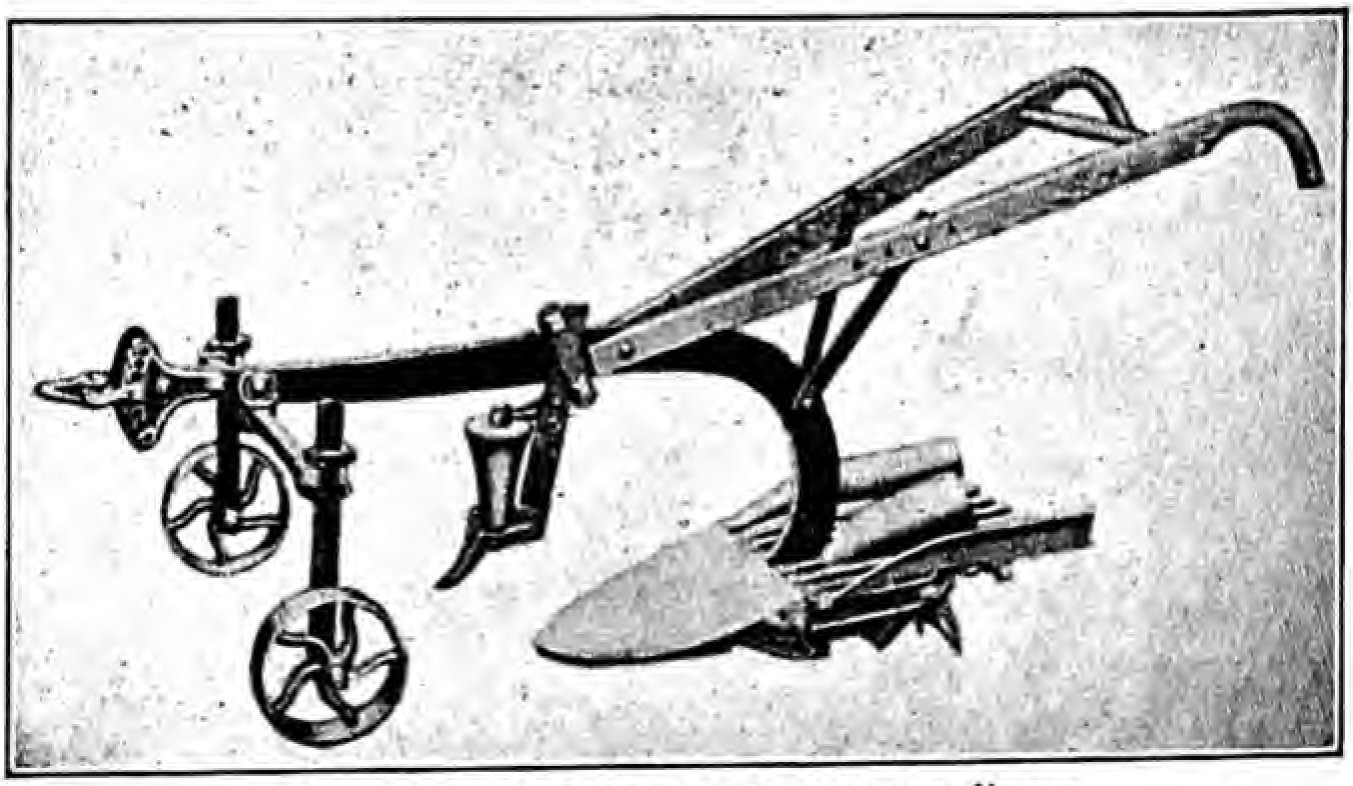


FIG. 533.—Walking shaker potato digger.

455. Riding Potato Diggers.—The digger shown in Fig. 534 may be considered as a standard one-row ground-driven horse-drawn potato-

harvesting machine. It is commonly called an *elevator* digger. The potatoes, vines, and soil are scooped up by the shovel onto the elevator.

The elevator is made up of bent rods forming an open carrier chain. Each alternate link is raised and lowered to form pockets to elevate the potatoes. As the elevator revolves, it is agitated by elongated or oval-

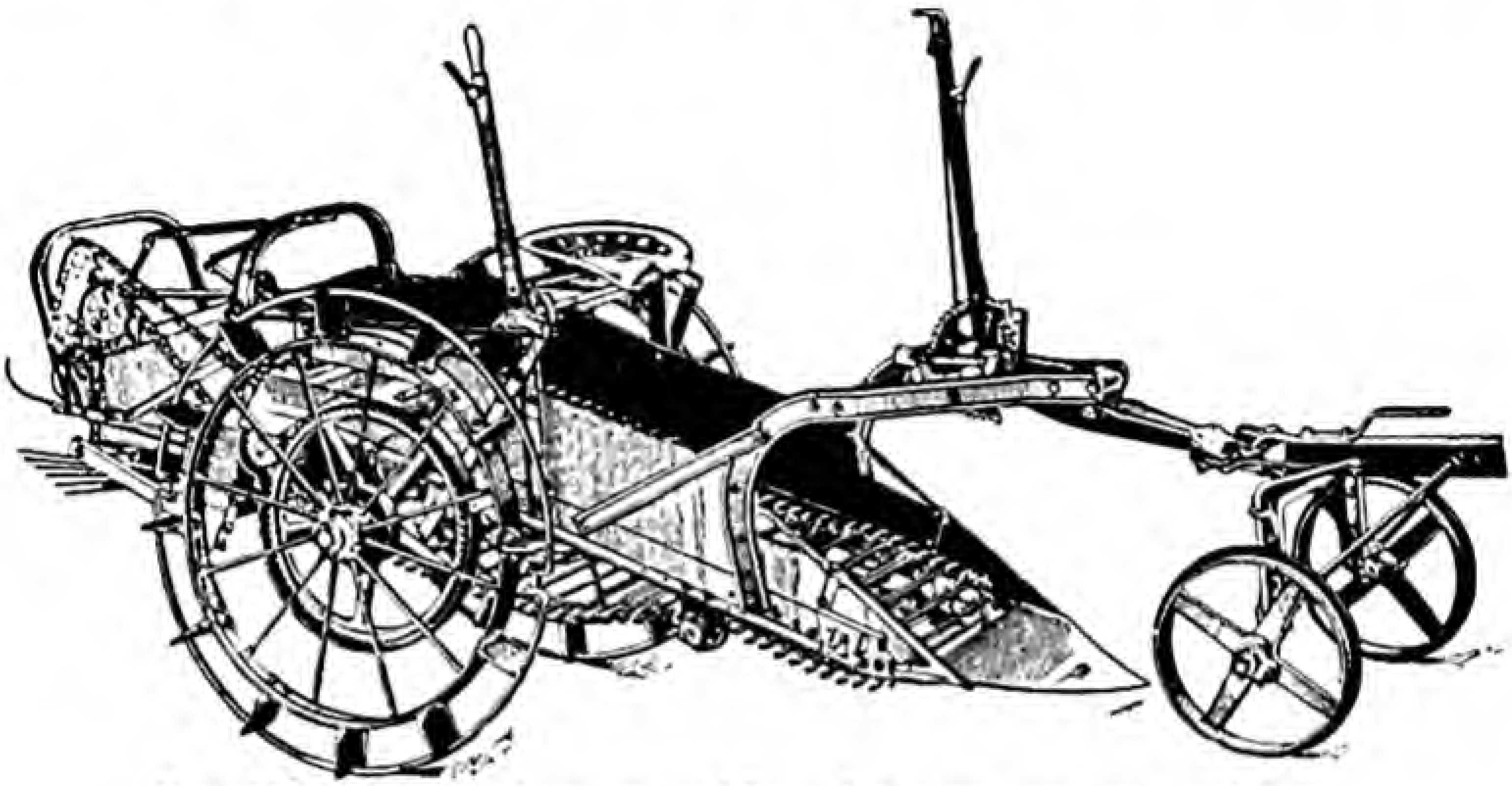


FIG. 534.—Standard one-row riding elevator-type potato digger.

shaped sprockets (Fig. 535), which give the elevator a brisk up-and-down motion to shake out the soil. The potatoes and vines are carried back to the rear shaker and vine turner, which deflects the vines to the side, leaving the potatoes and vines separated on the ground. Two drive wheels equipped with large lugs furnish power for the elevator, the power

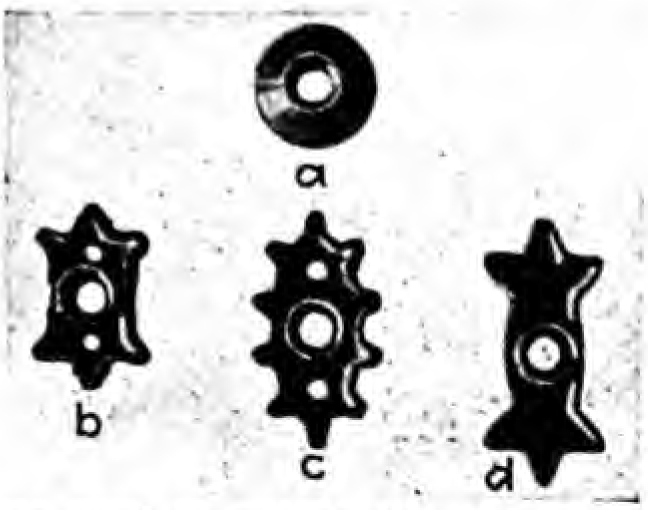


FIG. 535.—Agitator sprockets used on potato-digger aprons. *A*, for loose sandy soil; *B* and *C* provide normal agitation; *D*, for extreme agitation.

being transmitted by means of gears and shafts. Horse-drawn diggers equipped with rubber tires and an auxiliary engine can be obtained.

POWER-DRIVEN POTATO DIGGERS

The elevating mechanism of both the one- and two-row tractor-drawn potato diggers is driven by the power-take-off of the tractor.

456. One-Row Power-driven Potato Digger.—The one-row power-take-off-driven potato digger shown in Fig. 536 is equipped with a long drive shaft which connects at the rear to an enclosed gear box. This

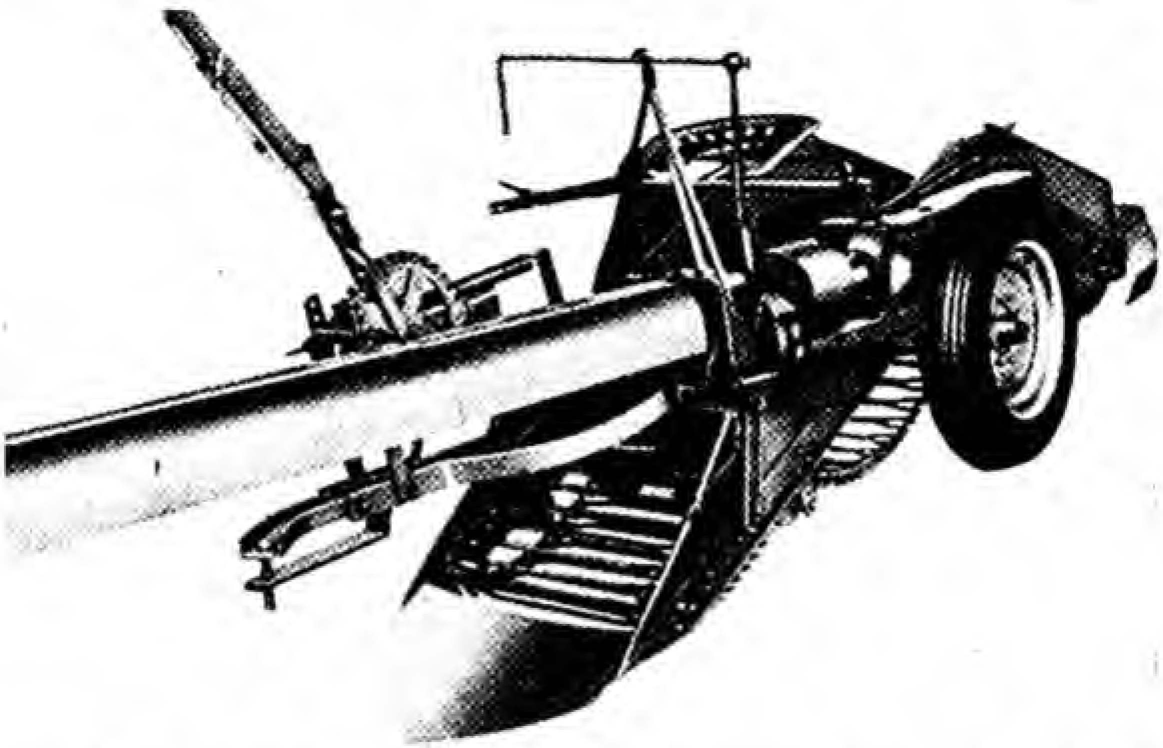


FIG. 536.—One-row power-take-off-driven potato digger, equipped with three-speed over-drive transmission.

gear box is really a three-speed transmission which permits the elevator to be operated at speeds suited to the field conditions. The elevator apron can be reversed to dislodge a stone. Fast speeds are necessary when the potatoes are hard to clean, but the potatoes are more likely

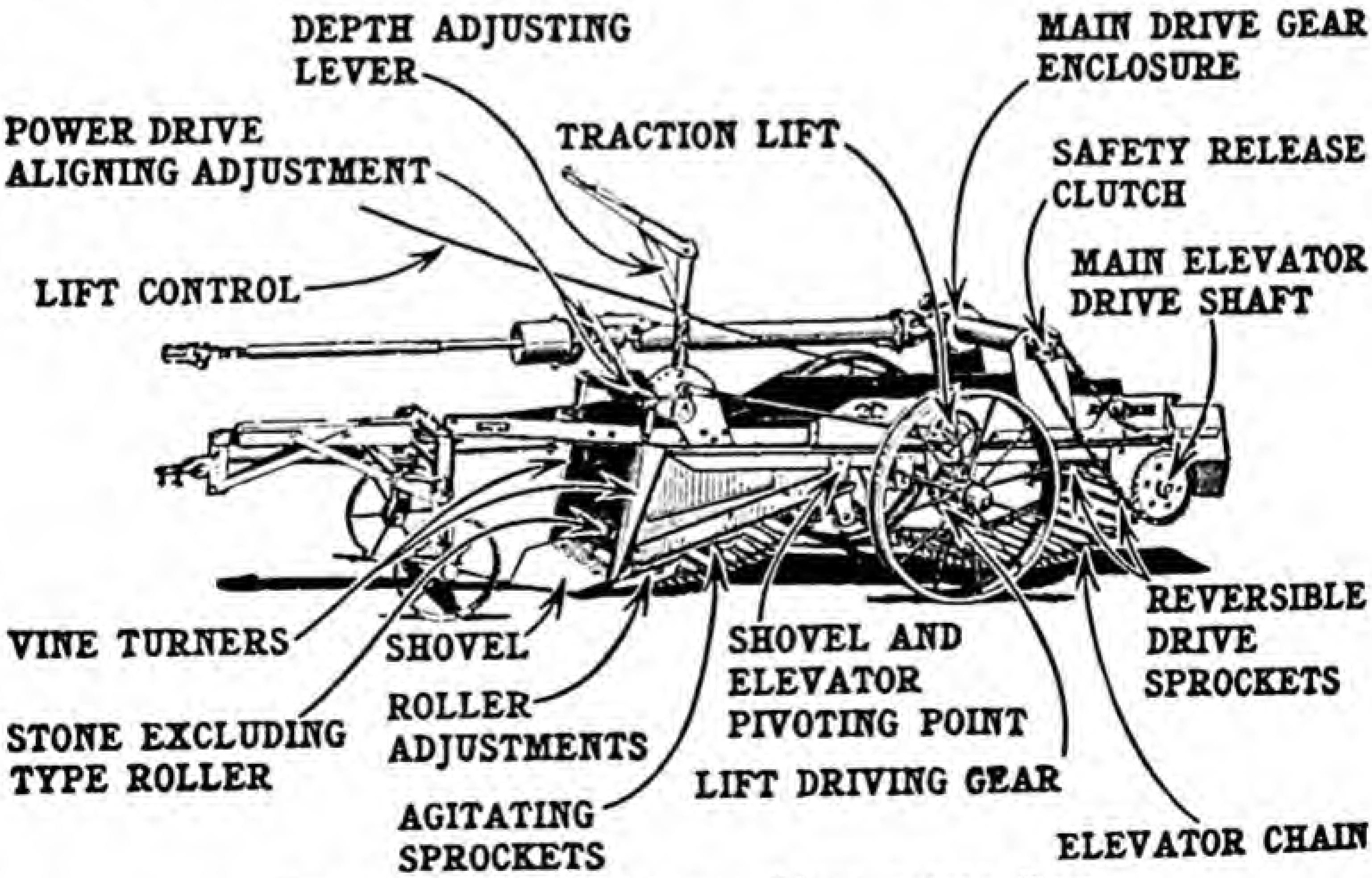


FIG. 537.—Level-bed power-driven potato digger.

to be bruised. Several types of shovels for scooping up the soil and potatoes can be obtained. Machines are also especially designed and others are adaptable for level-bed digging (Fig. 537). Either the continuous- or divided-type elevator may be used (Fig. 538), depending upon

field conditions. Agitators cause the top of the apron, conveying the potatoes, to vibrate up and down and sift the soil from the potatoes.

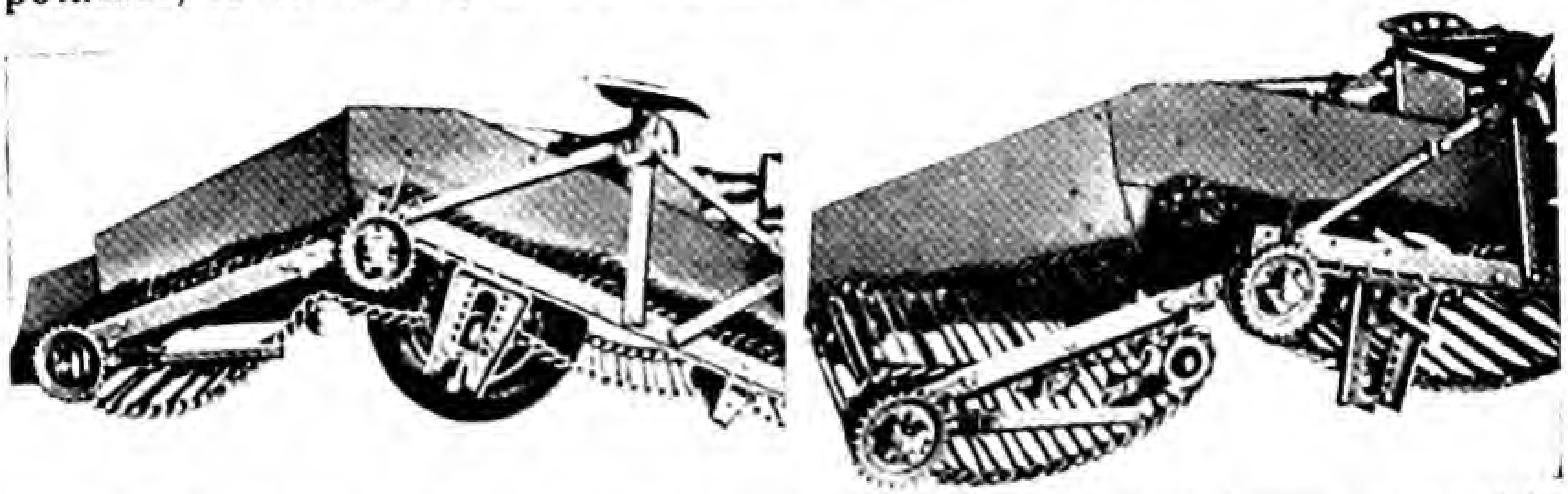


FIG. 538.—Two types of apron used on potato diggers: *left*, the continuous apron; *right*, the divided apron.

457. Two-Row Power-driven Potato Diggers.—The two-row potato digger consists, in a way, of two single-row units mounted on a long heavy axle with a suitable frame (Figs. 539, 540, and 541). The power drive shaft is located between the units. Levers permit the adjustment, for depth, of each unit separately. Deflectors at the rear of the elevator apron throw the potatoes from the two rows fairly close together, which

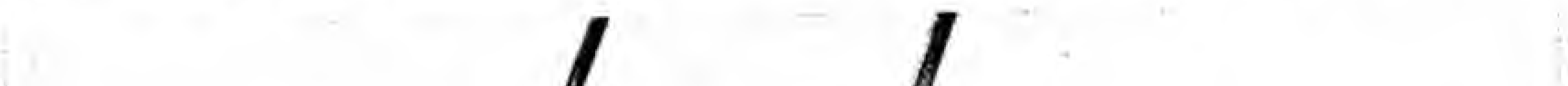


FIG. 539.—Two-row power-driven tractor-operated potato digger.

aids in picking them up. The large disks shown between the shovels in Fig. 539 cut and divide the vines.

458. Pickers and Baggers.—The bagger is a separate unit and is attached behind the regular potato digger (Fig. 542). Instead of dropping on the ground, the potatoes are delivered onto the elevator apron of the bagger. As the apron travels backward men standing on special

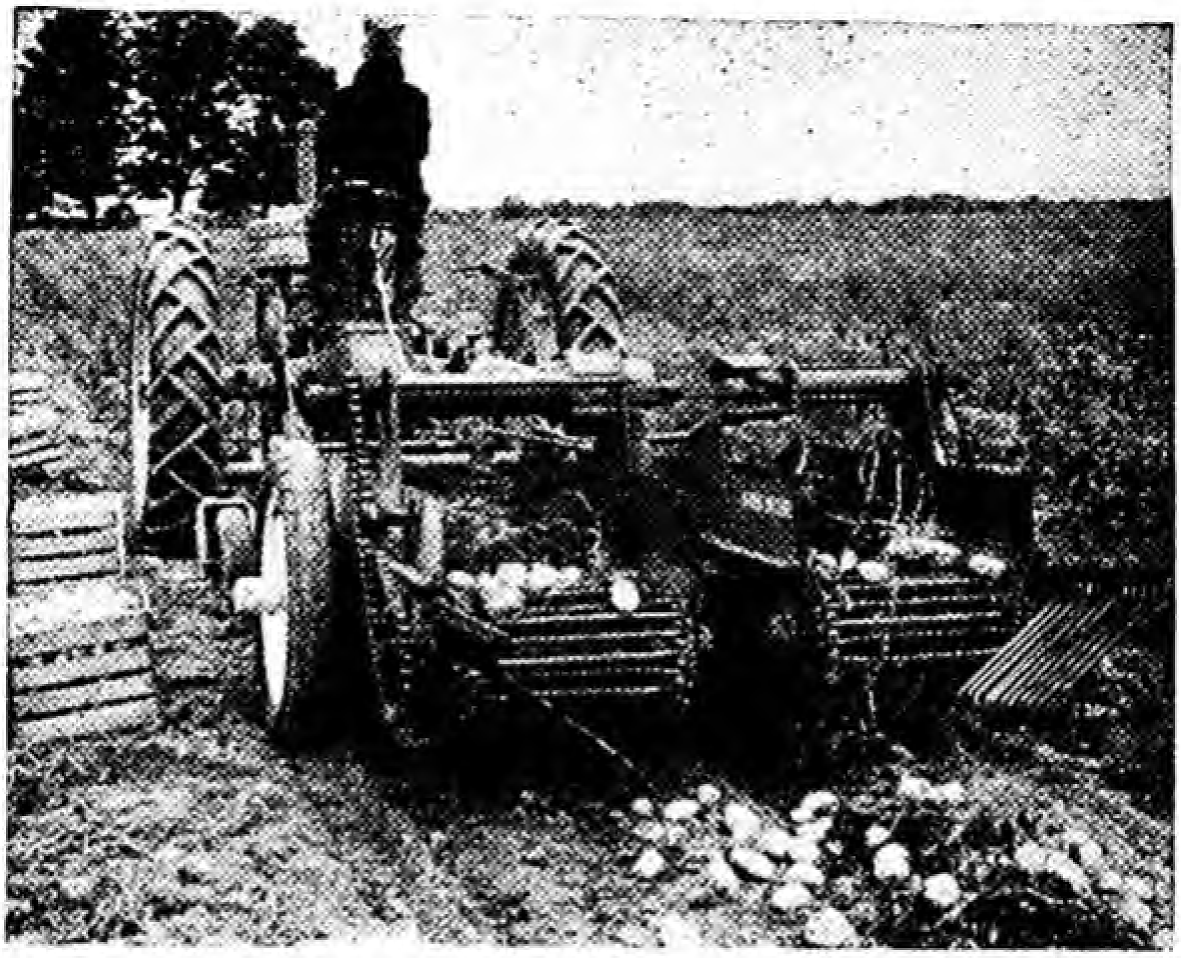


FIG. 540.—Rear view of two-row power-driven potato digger in operation.

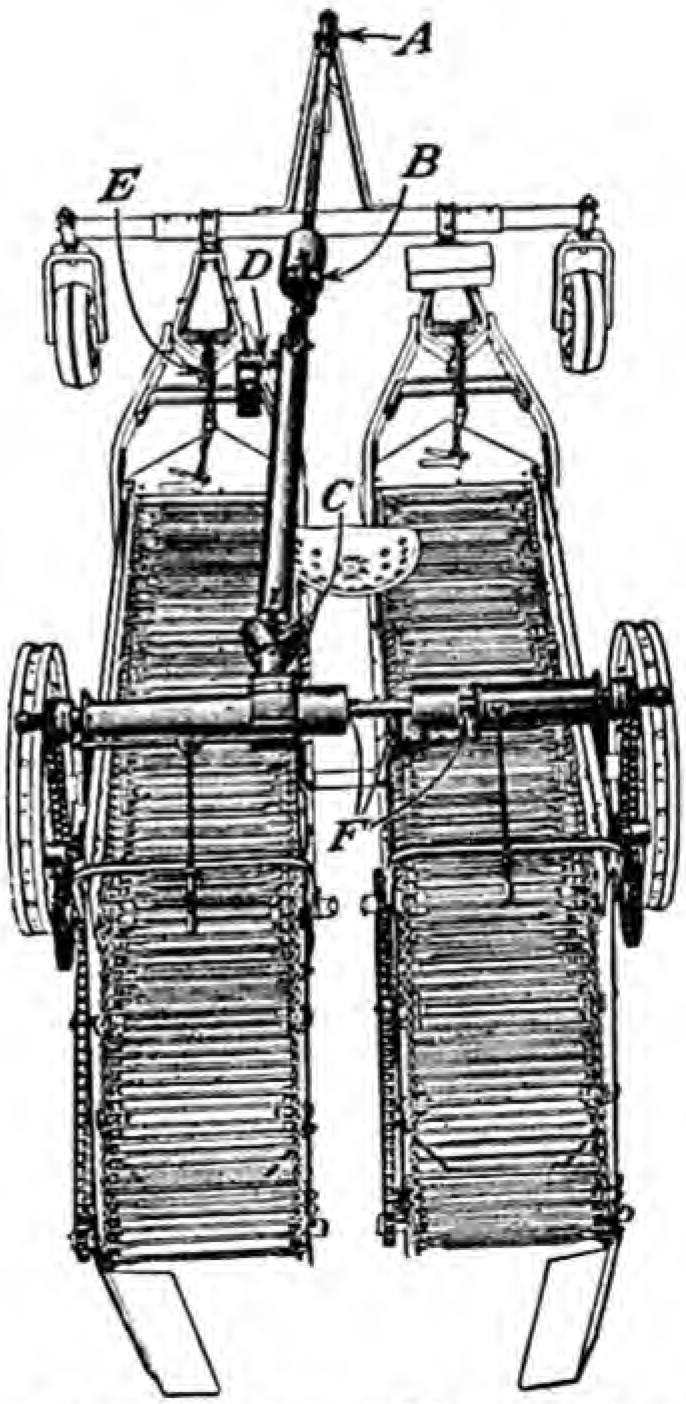


FIG. 541.—Overhead view of two-row power-driven continuous-apron potato digger.

supports on each side can pick out undesirable material, leaving only the potatoes to drop into the bag at the rear. The machine shown at the left in Fig. 542 is a picker and crating attachment that can be obtained for the potato digger.

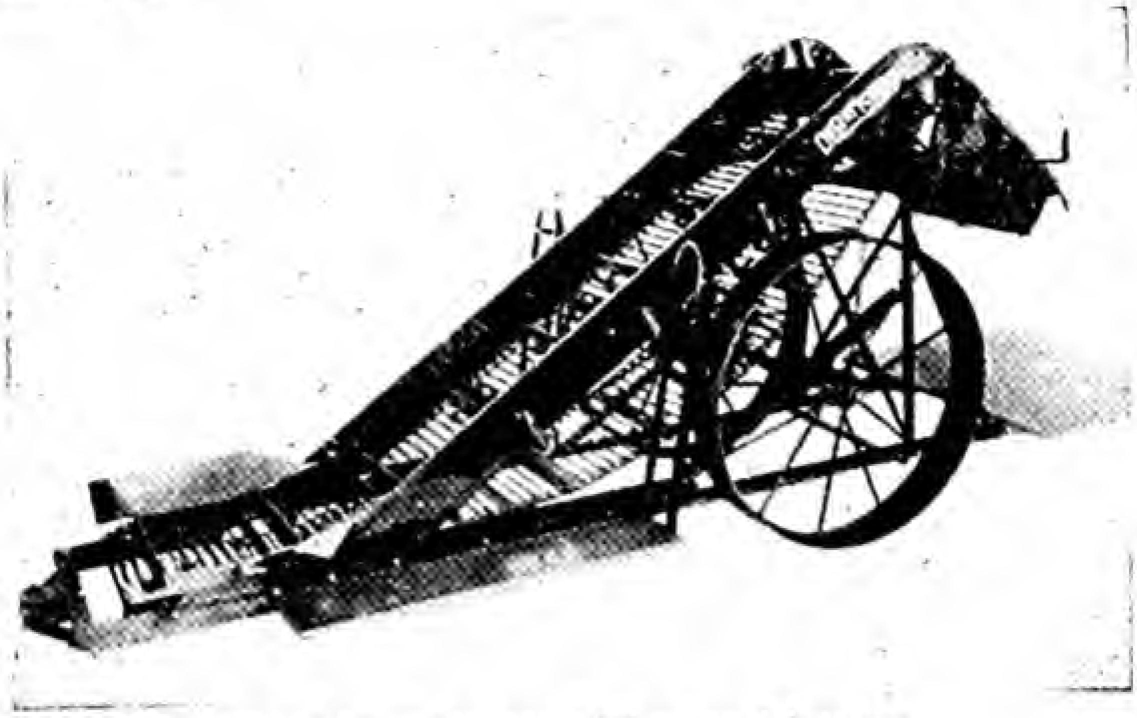


FIG. 542.—Potato picker and bagger.

HARVESTING SWEET POTATOES

The sweet potato has long tangled vines which make harvesting difficult. It is necessary that these vines be cut before any machine can be used to uproot the potatoes.

Regular potato diggers can be used to good advantage where a coulter or special cutter to cut the vines is attached to the machine.

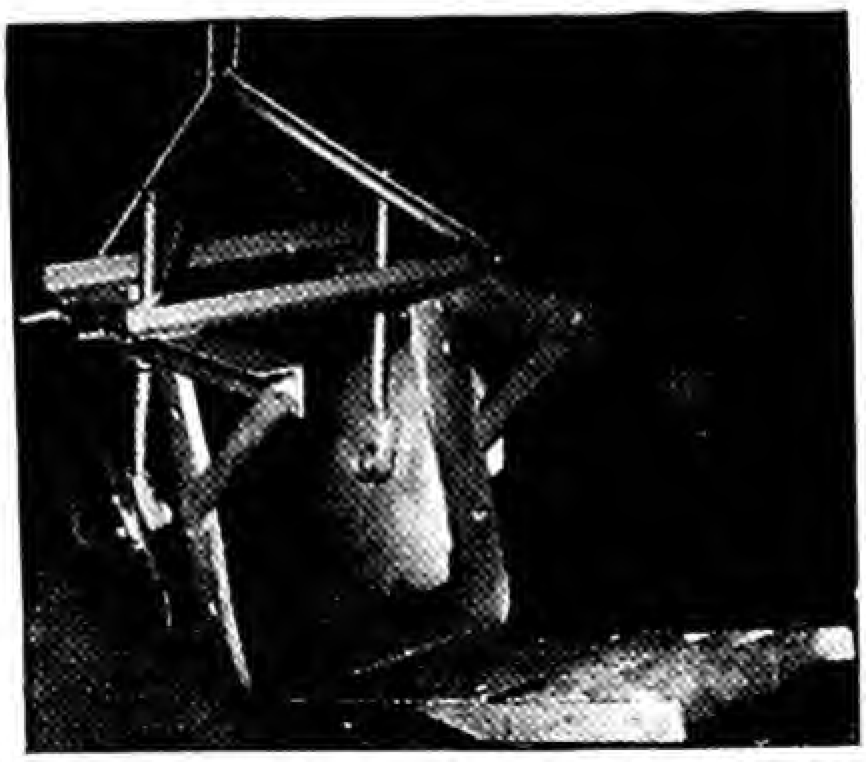


FIG. 543.—Homemade sweet-potato lifter equipped with notched coulters to cut the vines on each side of the bed.

During recent years tractor-mounted sweet-potato diggers have given good performance. The experimental machine shown in Fig. 543 simply slides under the soil and the potatoes, loosens the soil, and forces the potatoes to the surface where they can be easily lifted out of the soil

by hand. The marketable potatoes can be crated while the small culls and vines can be collected, sliced, chopped, and dried for livestock feed.

Special sweet-potato-vine harvesters are being developed.

PEANUT DIGGERS

The digging of peanuts involves loosening of the peanut and the vine in the soil. They are then either lifted by hand or windrowed by special

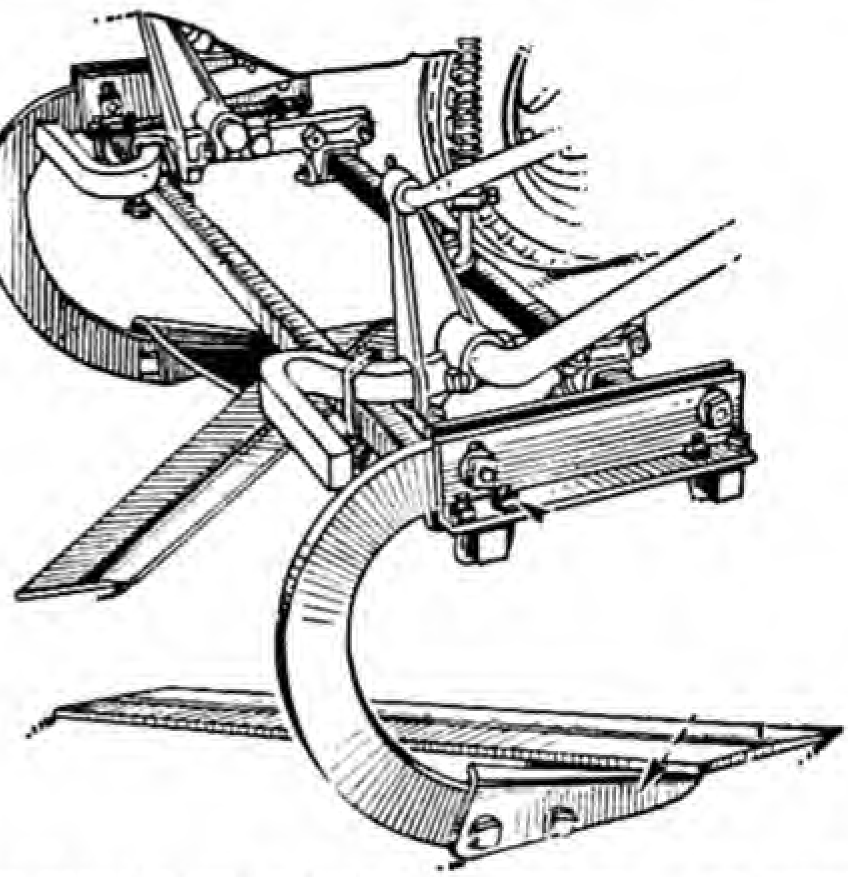


Fig. 544.—Peanut-digger attachment set to dig two rows. An attachment on each side of a tractor makes it possible to dig four rows at a time.

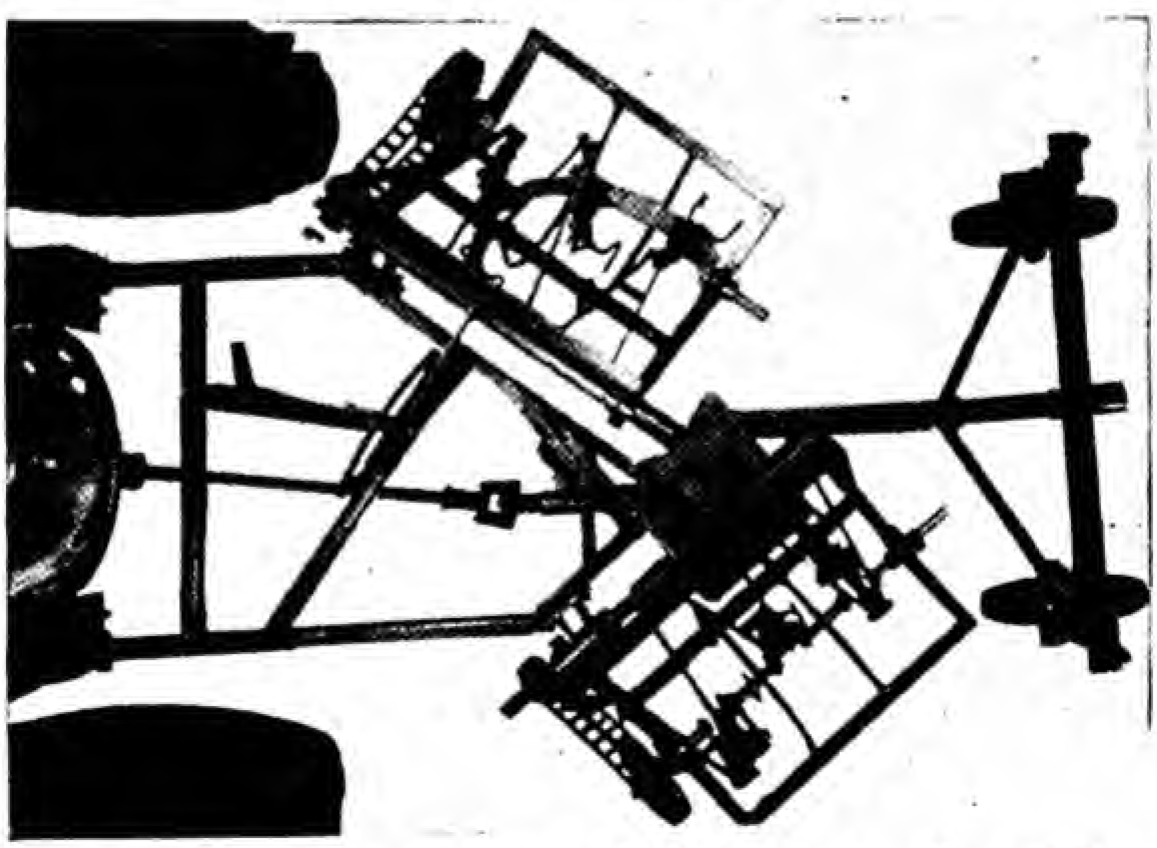


Fig. 545.—Peanut shaker and windrower. (*U. S. Dept. Agr. Farm Tillage Laboratory.*)

tools or by a side-delivery rake. The cultivator peanut-digging attachment shown in Fig. 544 consists of right- and left-hand half sweeps with long wings. The front edge of the wing is sharp so that it can be run underneath the peanuts, loosening the soil about the nuts and at the same time severing the tap roots. There is also a tendency to push

the vines of the two rows toward each other. The side-delivery rake is used extensively to lift the vines and nuts free of the soil and roll them into loose windrows so they can be picked up and threshed with a peanut pickup combine thresher. An experimental windrowing machine is shown in Fig. 545.

BEET DIGGERS

Beets, like cotton, have been a difficult crop to mechanize so that hand-labor requirements will be minimized. With the machines already developed, one-half to two-thirds of the 1945 beet crop was harvested mechanically.

Beet diggers can be divided into two classes, namely, *beet lifters* and *automatic topper-lifter-harvesters.*

459. Beet Lifters.—The beet lifter does nothing more than lift the beets out of the ground. They are then topped by hand. Figure 546

Fig. 546.—Two-row trailing tractor-drawn beet lifter.

shows a two-row trailing tractor-drawn beet lifter, while Fig. 547 shows a single-row integral centrally mounted tractor beet lifter.

460. Automatic Topper-lifter Beet Harvester.—During the past few years tremendous strides have been made in developing one-man automatic beet harvesters. There are at least four types in use by farmers.

A type used extensively in California consists of a 6-foot wheel on which there are large spikes that catch the beets and pull them out of the loose soil (Fig. 548). As the wheel revolves, carrying the beets on the rim, chisels at the top of the machine cut off the tops. The beets pass over a screen onto an elevator that delivers them to a wagon or truck traveling beside the harvester.

The second beet harvester is tractor-mounted (Fig. 549). This machine tops the beets before they are lifted. Mounted on the front of

the tractor is a leaf trimmer consisting of two rolling coulters operating in conjunction with a scraper. This device trims off leaves along each side of the row and pushes them out of the way of the topping device suspended under the tractor. As the tops are cut off they are elevated

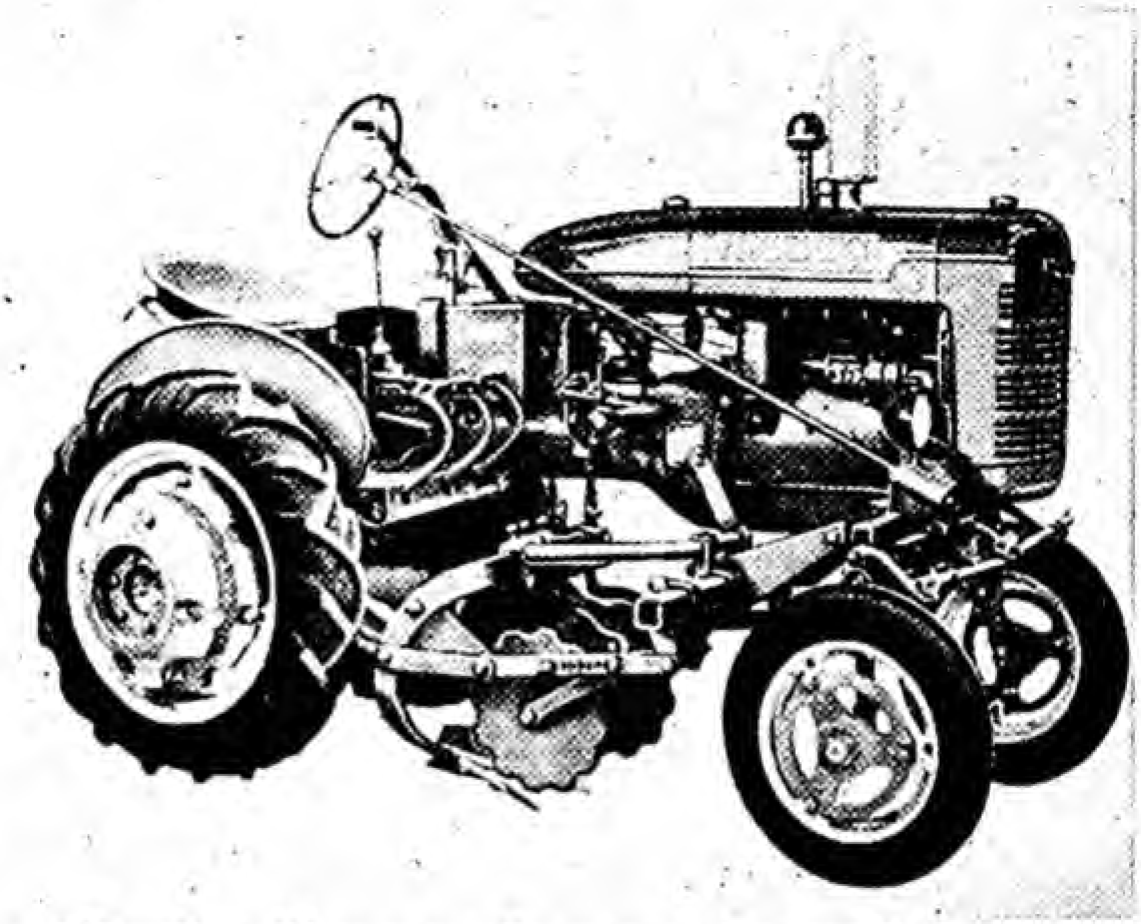


FIG. 547.—Beet lifter centrally mounted on small-sized tractor.

by a revolving drum onto a cross belt, which delivers them into windrows on land where the beets have been harvested. As the topped beets are lifted from the ground by the puller points, two beater frames grasp the

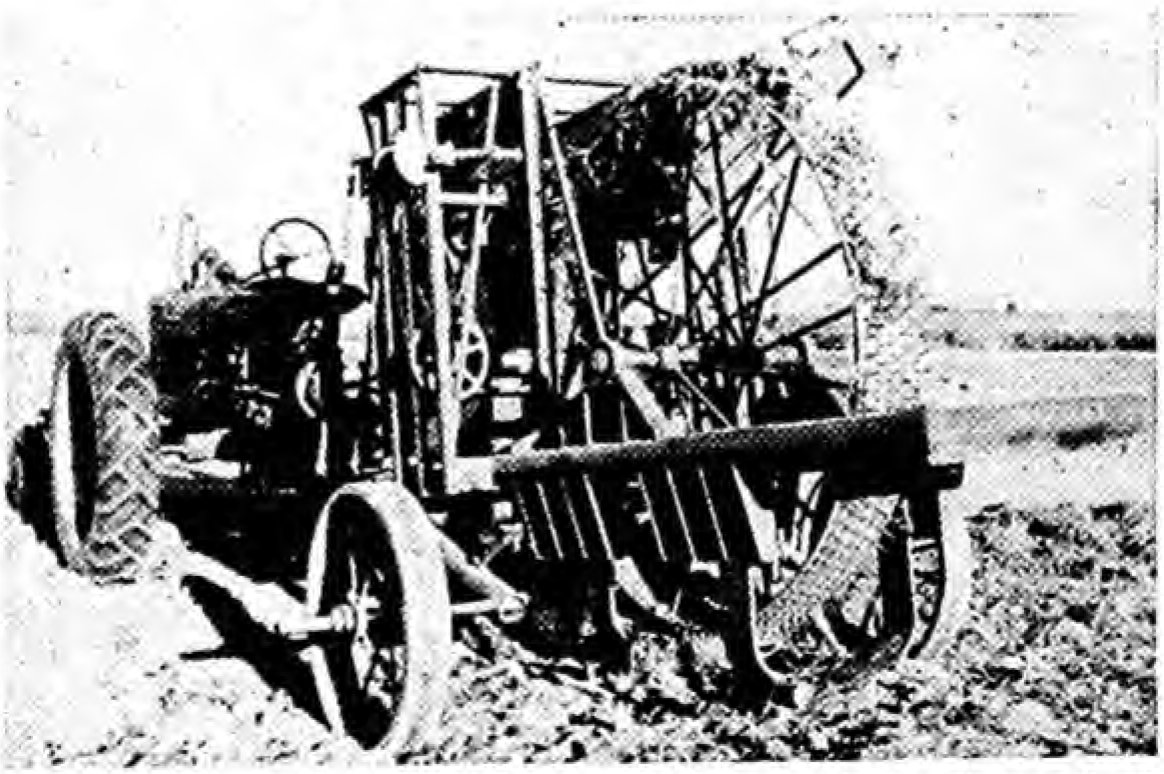


FIG. 548.—Beet digger equipped with large wheel, on the surface of which are spikes which pick the beets from the loose soil. (*Bur. Plant Ind. Soils and Agr. Engin.*)

beets and deliver them onto a chain elevator which conveys them to one side. Six or eight rows are piled together in a single windrow. A loader then picks up the windrow of beets and loads them onto a truck.

The third type of beet harvester is shown in Fig. 550. This machine

also has a leaf trimmer in front, suspended under the tractor, to remove surplus side leaves and clean the row ahead of the topper. After topping,

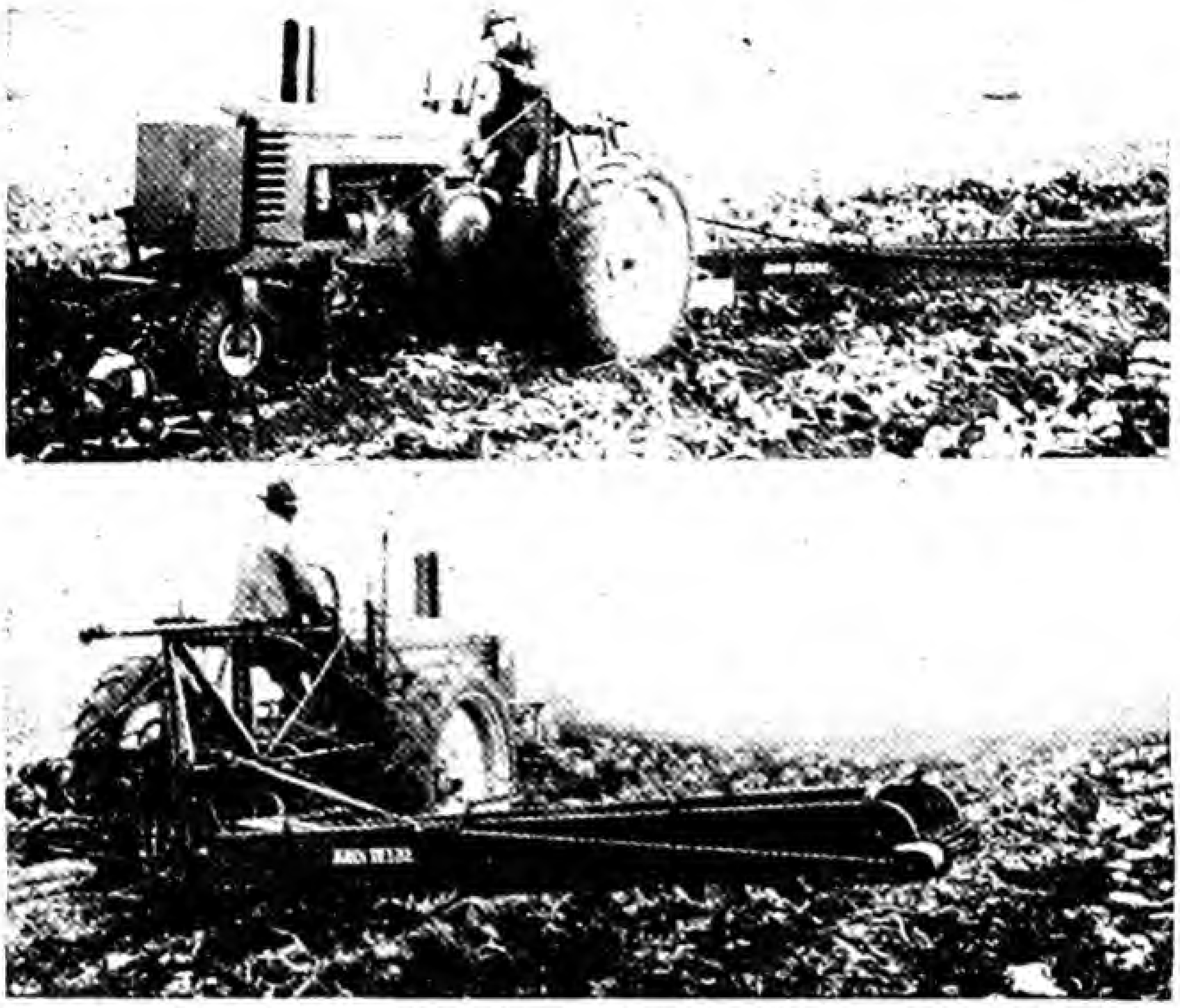


FIG. 549.—Front and rear views of beet digger that tops, lifts, conveys, and places the beets in windrows. (*Bur. Plant Ind. Soils and Agr. Engin.*)

the beets are lifted and elevated, then passed over a screen and dropped onto a wide belt which operates across the top of a trailer cart. Two

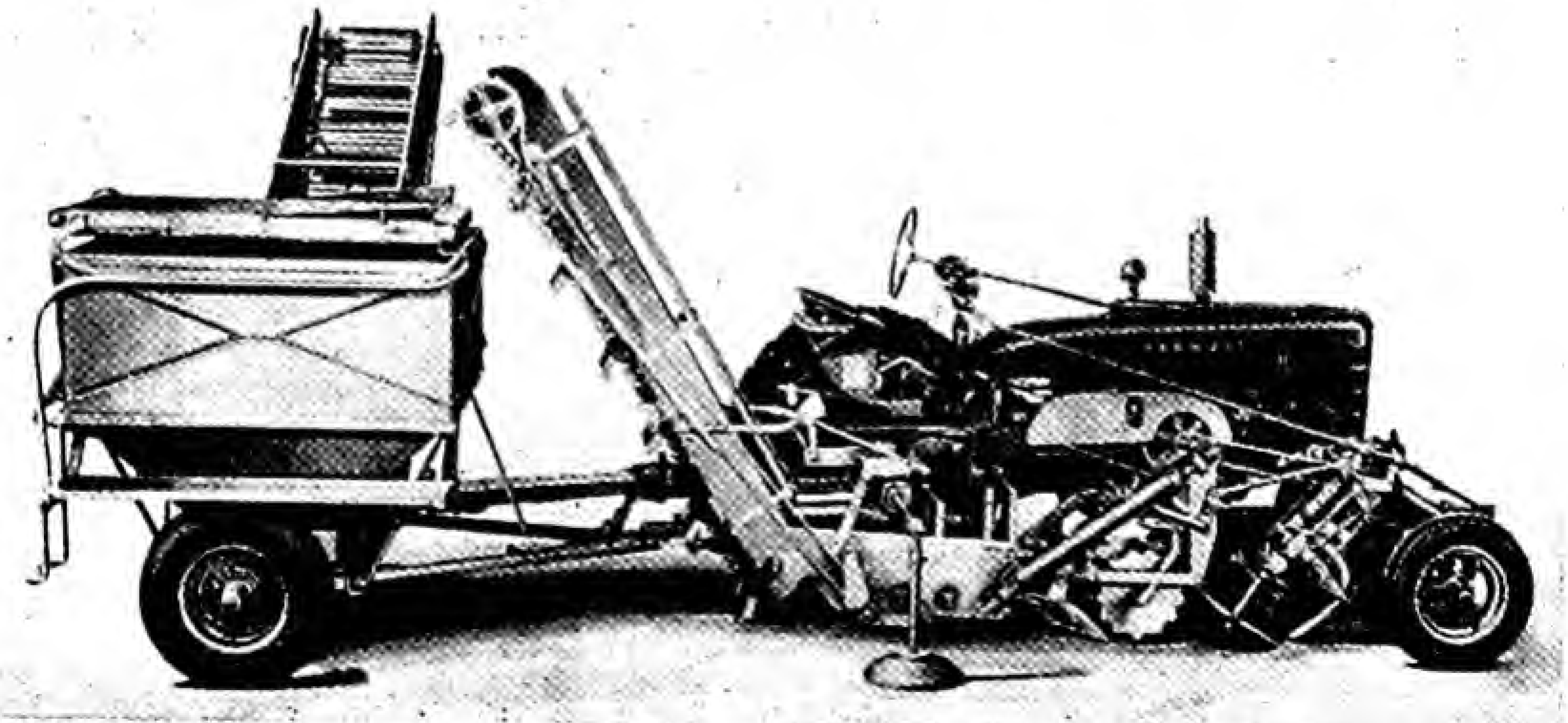


FIG. 550.—Beet digger with tractor wheel removed to show the various parts. Note that the trailer cart is equipped with sorting belt and unloading elevator.

men on each side of the machine flip the beets into the cart hopper. Clods of dirt and waste are conveyed and dropped by the belt over the

rear of the hopper. An elevator extending from the bottom of the hopper elevates the beets onto a truck. Figure 551 shows a cross-sectional view of this digger.

The fourth type of beet harvester lifts the beets by their tops after the beets have been plowed loose. The topping is done in the machine

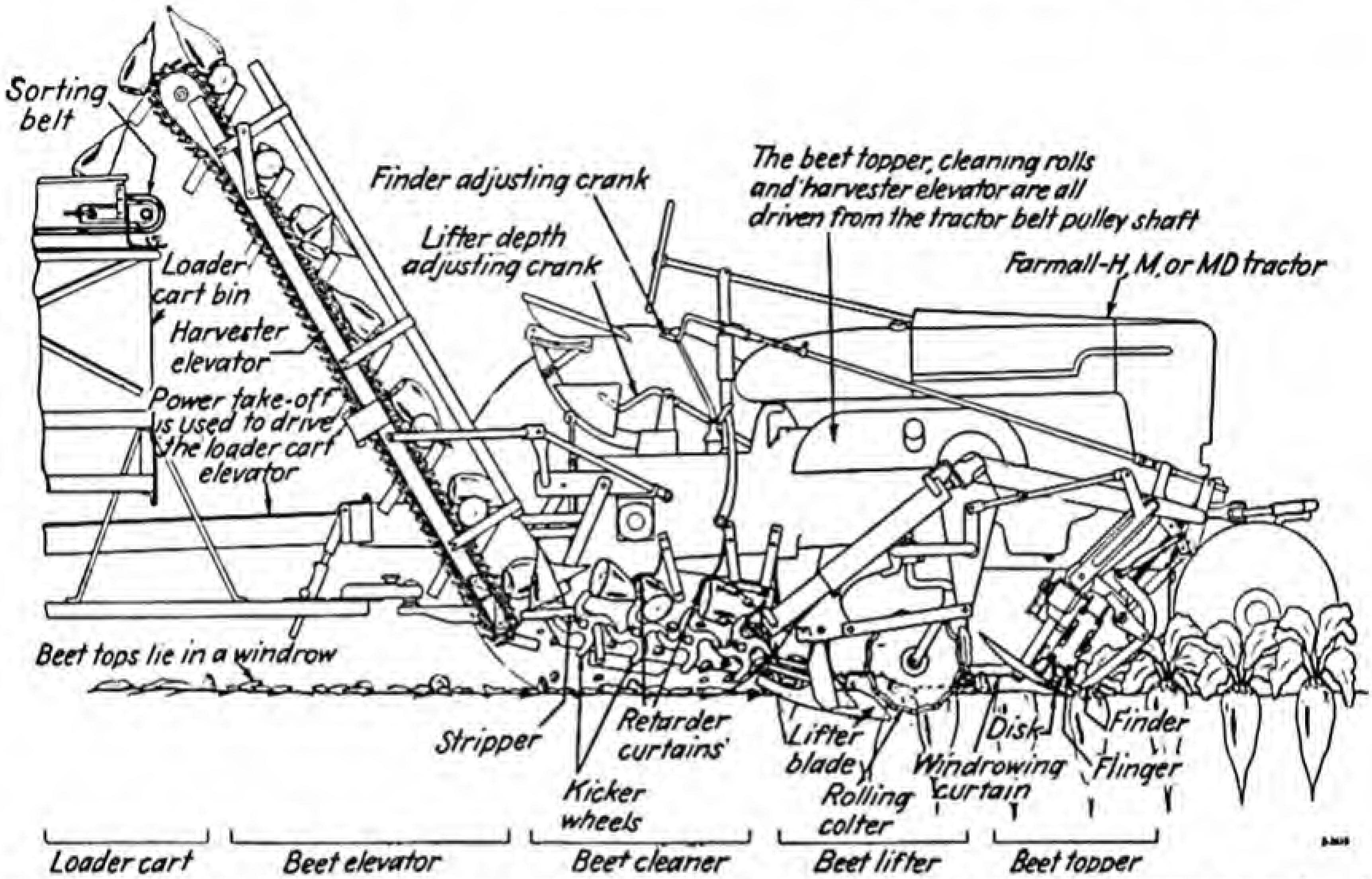


FIG. 551.—Cross section of beet digger shown in Fig. 550 with the various parts named and steps in operation indicated.

by a pair of revolving disks. The beets are then delivered to a truck traveling beside the harvester.

HARVESTING PEAS, BEANS, SOYBEANS, AND GRAIN SORGHUMS

Combines are used extensively in the harvesting of dry peas, beans, and soybeans.

The development of dwarf types of grain sorghums (milo) now makes it possible to use the combine in harvesting millions of acres of grain sorghum.

SUGAR-CANE HARVESTERS

Sugar cane is another crop for which it has been difficult to develop a satisfactory mechanical harvester. This was because the stalks had to be severed close to the ground, the excess leaves and husk removed, and the green watery top cut off and discarded. The use of a chemical dust to kill the green foliage so it can be burned greatly simplifies the problem. This, of course. makes it necessary to harvest and process the burned-

over stalks within a few days after burning has been done, otherwise the sweet juice will sour.

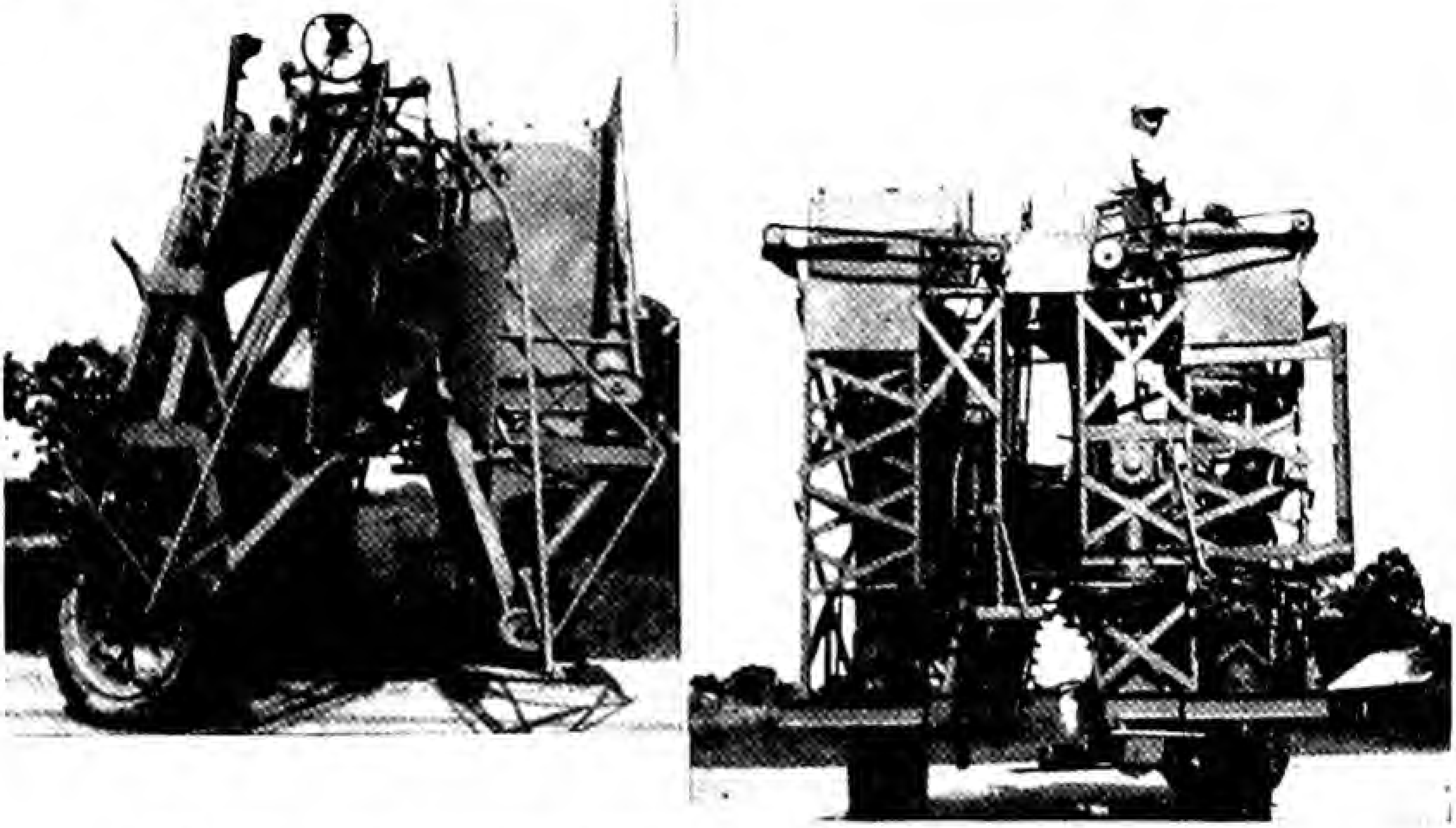


FIG. 552.—Front and rear views of self-propelled sugar-cane harvester.

461. Self-propelled Sugar-cane Harvester.—Figure 552 shows front and rear views of a self-propelled sugar-cane harvester. The machine is

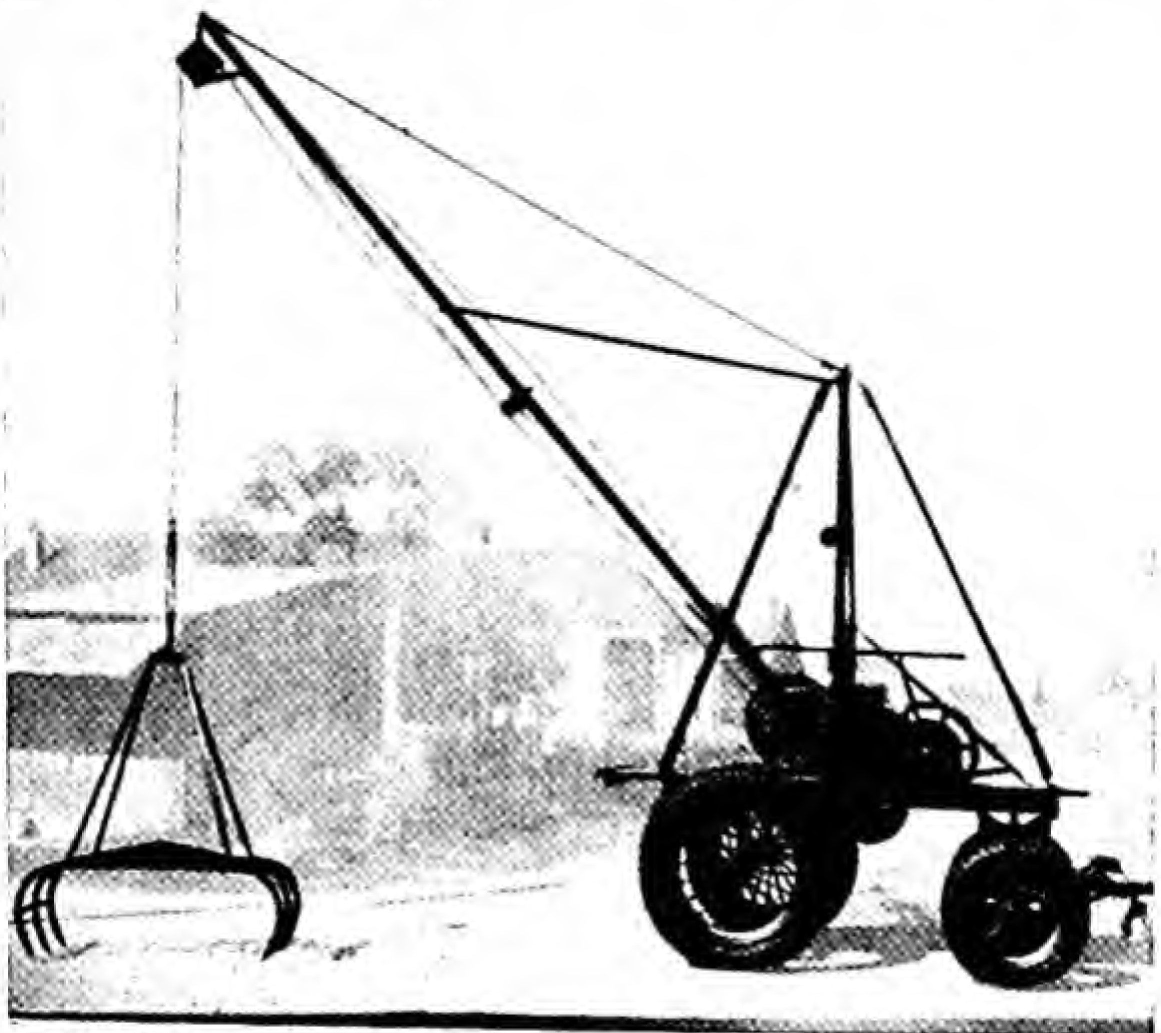


FIG. 553.—Cane loader equipped with 8- to 9-horsepower gasoline engine. The loader is drawn about the field with mules.

equipped with pickup chains, a circular blade for severing the stalks close to the ground, and a blade for cutting off the tops.

462. Cane Loaders.—Sugar cane is heavy and loading it into special types of trailers is slow hard work. Power-operated derricks and special power loaders are available which can lift heavy loads of cane. A small

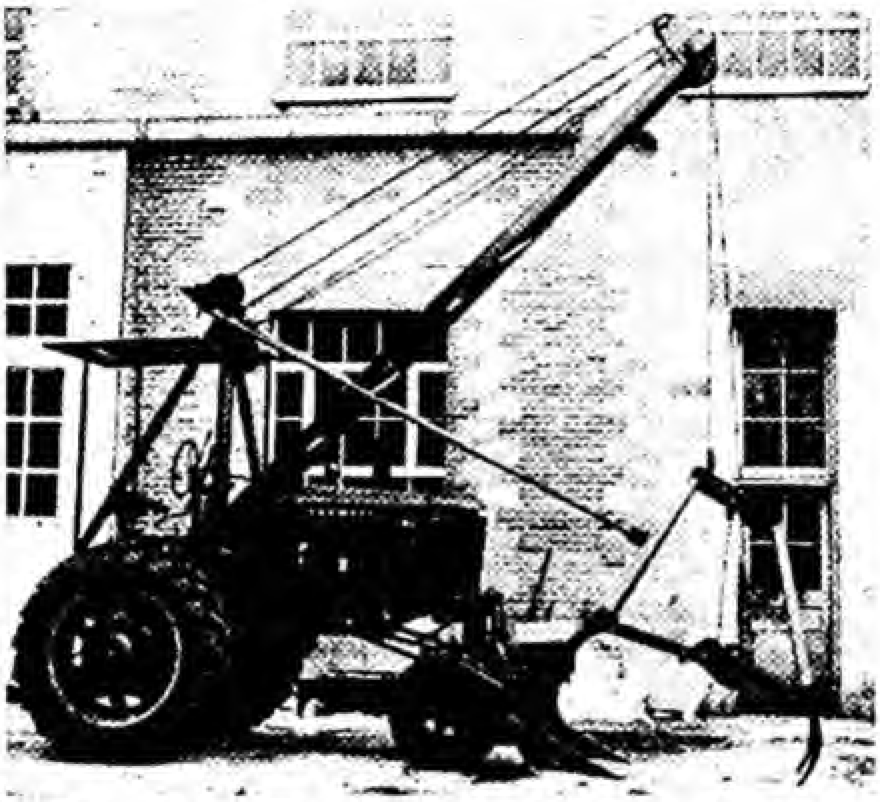


FIG. 554.—Tractor-mounted cane loader.

engine-powered loader equipped with grapple fork is shown in Fig. 553. A tractor-mounted and power-operated cane loader is shown in Fig. 554. Dragline equipment on track-type tractors is also used to handle large bundles of sugar-cane stalks.

PART IX
SEED-PREPARATION MACHINERY

CHAPTER XXV

THRESHERS AND COMBINES

In the preparation of many crops for the market, it is necessary that the seed be separated from the stalk on which they grew. All the small-grain crops must have the seed stripped from the straw, corn must be shelled from the cob, peanuts must be threshed or picked from the vines, and cottonseed must be separated from the lint. Different types of machines are necessary for the separation of the seed from the holding agent in the different crops. Generally, very large apparatus is necessary, incorporating a number of different operations in the same machine as the material passes through it.

GRAIN THRESHERS

The thresher is one of the largest field machines used in the processing of any field crop. In the true sense of the word, it is made up of a combination of several different machines, each having a special and separate function to perform in the separation of the grain from the straw. The modern grain thresher is a very efficient machine; when properly operated and given reasonable care it is durable and is perhaps more nearly perfect in operation than any other machine used on the farm. It not only threshes, separates, and cleans the grain thoroughly, but accurately weighs it and delivers it into the bag, wagon box, or granary, and delivers the straw to the stack or into the barn. The whole process from the time the bundles are delivered to the feeder until the task is finished requires only about 30 seconds.

463. Functions of a Thresher.—The work performed by a thresher may be divided into six separate functions, which are

1. To feed the grain to the threshing cylinder properly.
2. To thresh the grain out of the head properly.
3. To separate the grain from the straw properly.
4. To clean the grain properly and deliver it to the weigher.
5. To weigh and record properly the amount of grain threshed.
6. To deliver the straw and chaff to the strawstack.

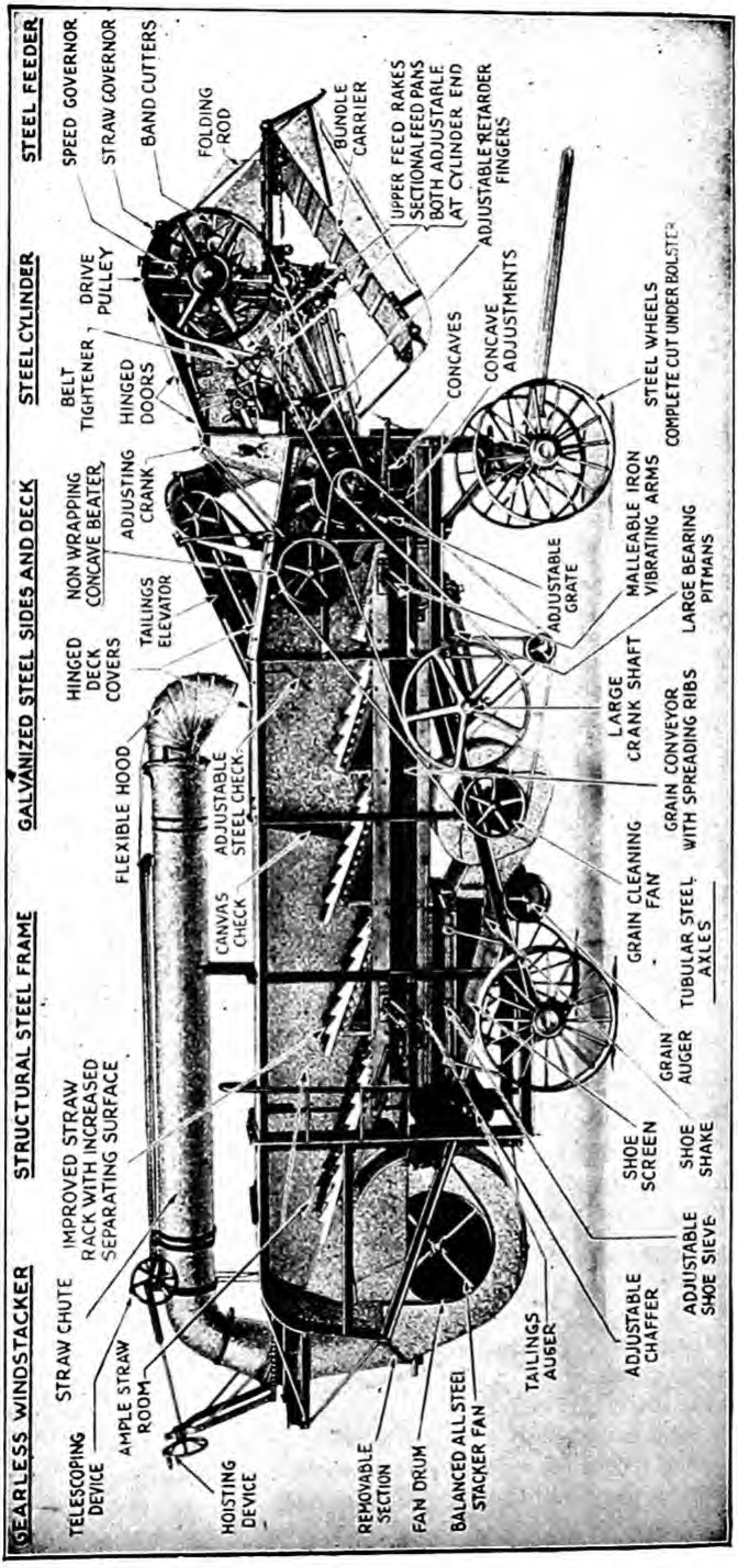


FIG. 555.—Sectional view of threshing machine showing all working parts.

All parts necessary for the performance of these functions, except the fifth, are shown in Fig. 555.

464. Self-feeder.—The feeder is a special attachment placed on the front of the machine, shown in Fig. 556. It is the most human-like part of the whole machine, because of the peculiar manner in which it feeds the grain into the threshing apparatus, regulates the amount fed, prevents choking, and cuts the bands. The success of a threshing job depends directly upon the manner in which the bundles are pitched

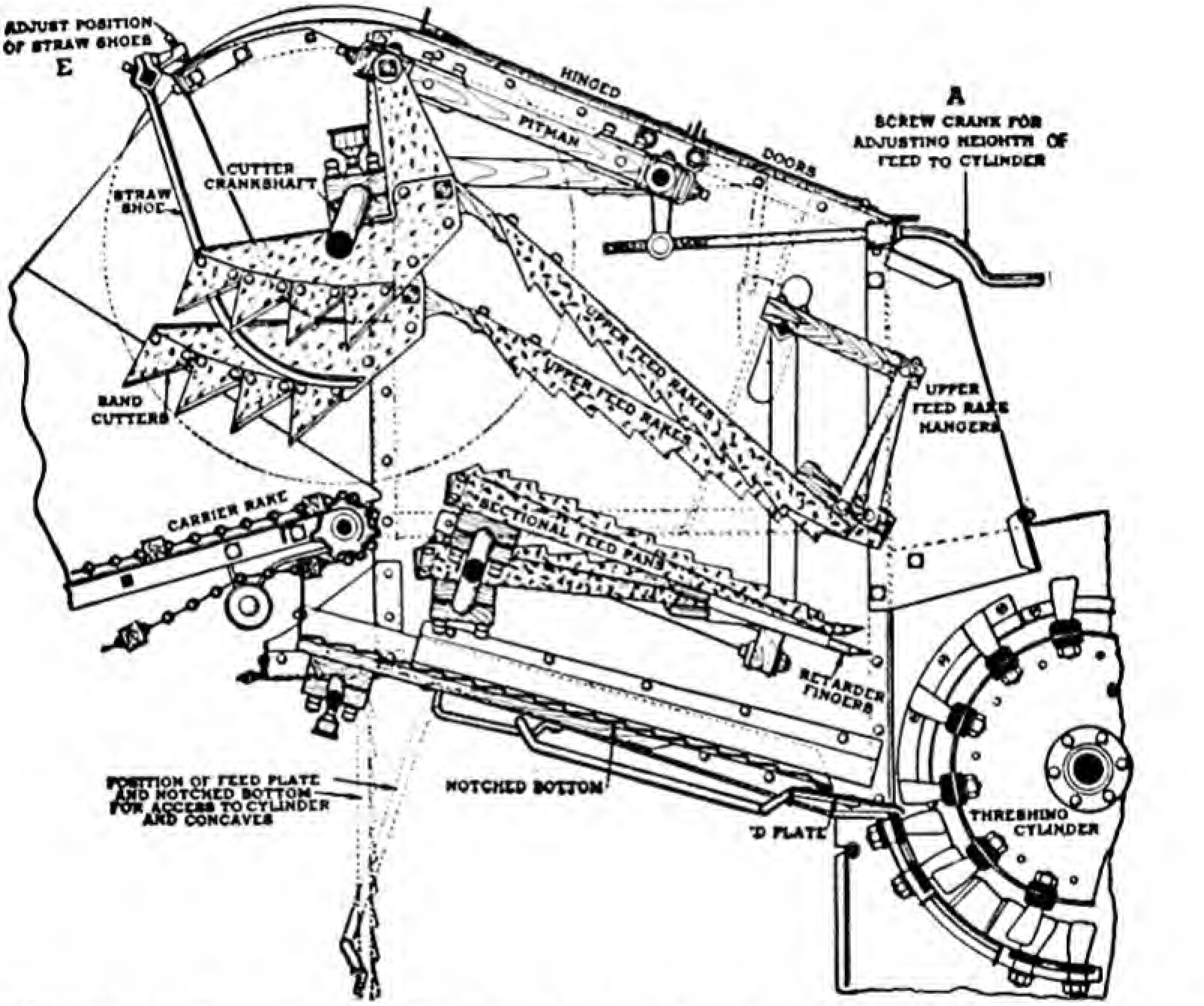


Fig. 556.—Sectional view of the parts making up the self-feeder and volume governor.

into the feeder and the manner of feeding. Both will have a great influence upon the grade of work done.

The bundles should be pitched onto the feeder carrier *heads first*. In the operation of a very large machine this feature is often lost sight of, and the bundles pitched in and let fall any way they will.

465. Threshing Apparatus.—The function of the threshing apparatus is to thresh properly the grain out of the head. The parts necessary to perform this function are the cylinder and the concaves. The position and relation of these parts to the other parts of the thresher are shown in Fig. 555. The function is accomplished by the cylinder teeth striking the grain hard enough to shatter the kernels from the head. The action

is assisted by the concave teeth which project up between the cylinder teeth.

There are three types of cylinders, named according to the kind and shape of the device used to remove the grain from the straw. The *tooth* cylinder has teeth on the bars; the *rasp bar* has corrugations that remove the grain by a rubbing action; the *rubber-edge angle bar* removes the grain by a beating action. The rubber on the edges of the bar helps to prevent cracking of the grain, as it forms a cushion.

466. Separating Apparatus.—The function of the separating apparatus is to separate properly the grain from the straw. The parts included in the separating apparatus are grates, beater, straw racks, check board, curtain, and grain conveyor or pan. The location and relation of these parts to the other parts of the machine are shown in Fig. 555.

467. Cleaning Apparatus.—The function of the cleaning apparatus is to clean the grain properly and deliver it to the weigher. This is accomplished by passing the uncleaned grain over a series of sieves and screens through which a current of air is forced, as shown in Fig. 557.

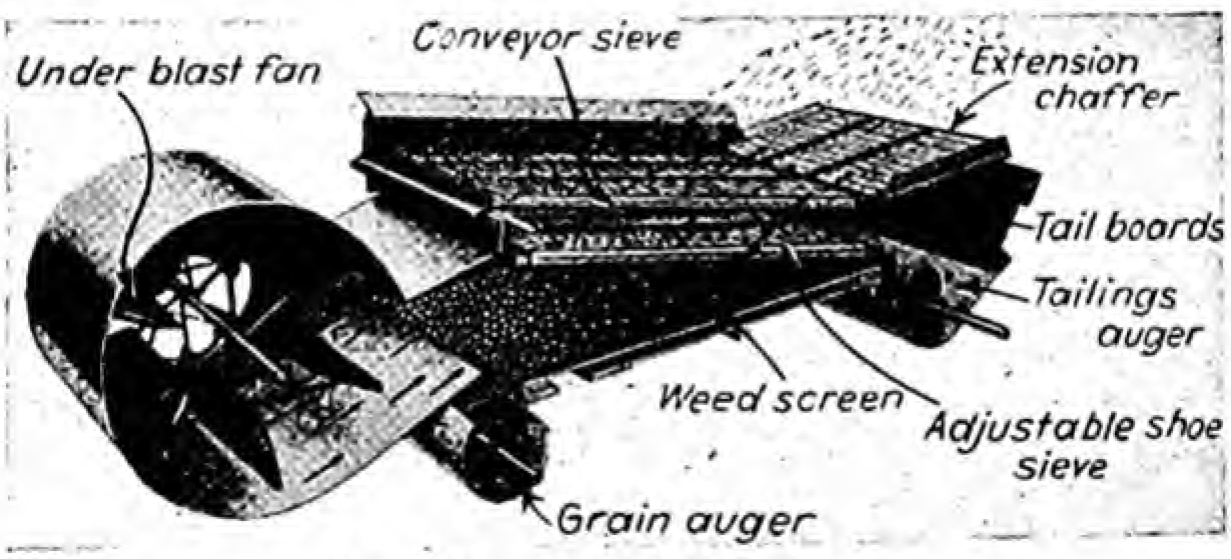


FIG. 557.—Cleaning apparatus.

The parts necessary to perform this function include shoe, chaffer, chaffer extension, sieves, screens, tailings elevator, and fan.

468. Weighing and Recording.—To weigh and record properly the amount of grain threshed, grain handlers are placed on the threshing machine to receive the fresh grain from the grain auger, elevate it, and deliver it to the loader or weigher. Loaders are nothing more than elevators with spouts for delivering the grain to the wagon or bagging attachment. When a weighing attachment is used, it has an elevator with a weighing and recording mechanism. In general, the various parts composing a weigher will consist of the following: hopper, scale beam, ship bracket, trip pin, trip dog, gear shaft, driving gear, elevator cut-off, hopper cut-off, and recorder. The weigher (Fig. 558) is a mechanism which automatically weighs a quantity of grain and then automatically

dumps it into a spout for bagging or directs it to the wagon. At the time the grain is dumped, it operates the registering device or recorder, which registers, by half bushels, the number of bushels threshed.

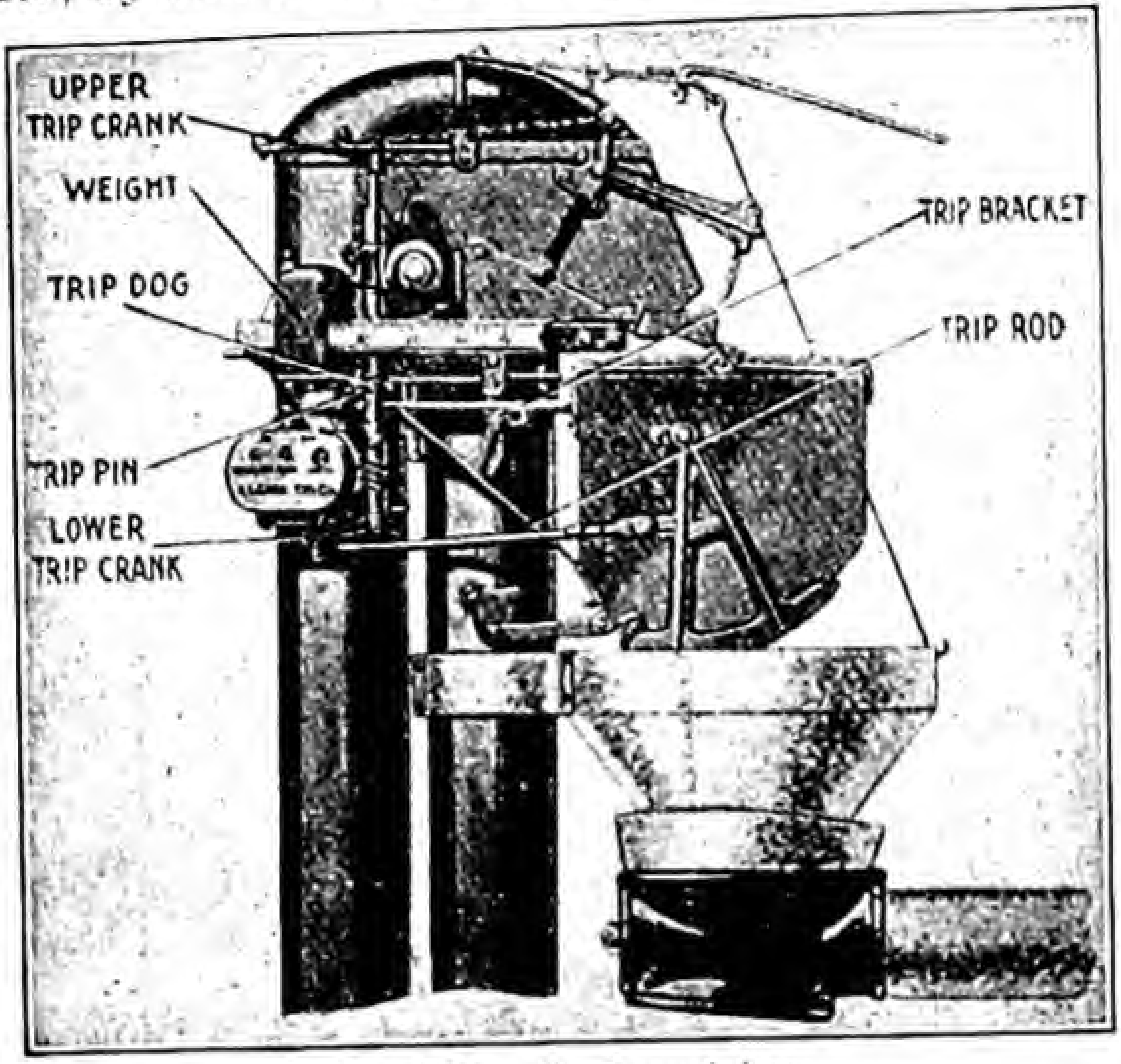


FIG. 558.—Grain weigher.

469. Strawstacker.—The function of the strawstacker is to deliver properly the straw and chaff to the strawstack by means of the wind stacker (Fig. 559). The wind stacker is being used almost universally and is very simple and compact in construction. The straw can be delivered to almost any place desired without the aid of men to do the stacking.

470. Size of Threshing Machine.—To determine the size of a threshing machine, two measurements must be taken: the width of the throat, or cylinder, and the width of the machine at the rear. These measurements will give the size of the machine. For a very small thresher, the width of the cylinder is 20 inches; the rear of the machine is 28 inches; then, the machine is a 20 by 28-inch thresher—about the smallest machine built. Large types of thresher may have a width at the cylinder of 40 inches and a width at the rear of 62 inches—making a 40 by 62-inch machine.

471. Setting a Thresher.—Many threshing-machine operators do not pay as much attention to the setting of the threshing machine before starting work as they should. Many times they just swing the thresher around in position, dig under the wheel that seems to be high to bring it down to what seems to be a proper level, bring the tractor up, put on the drive belt, and go ahead. Of course, the grain can be threshed when

no care at all is taken in setting, but the amount of grain that is secured is materially decreased.

To set a threshing machine properly, an ordinary carpenter's level should be used to see that the machine is level both lengthwise and crosswise. The level should be put on some part of the frame which is rigid so that there will be no mistake in getting it level. When set level, the sieves and screens can be given the proper inclination for good cleaning.

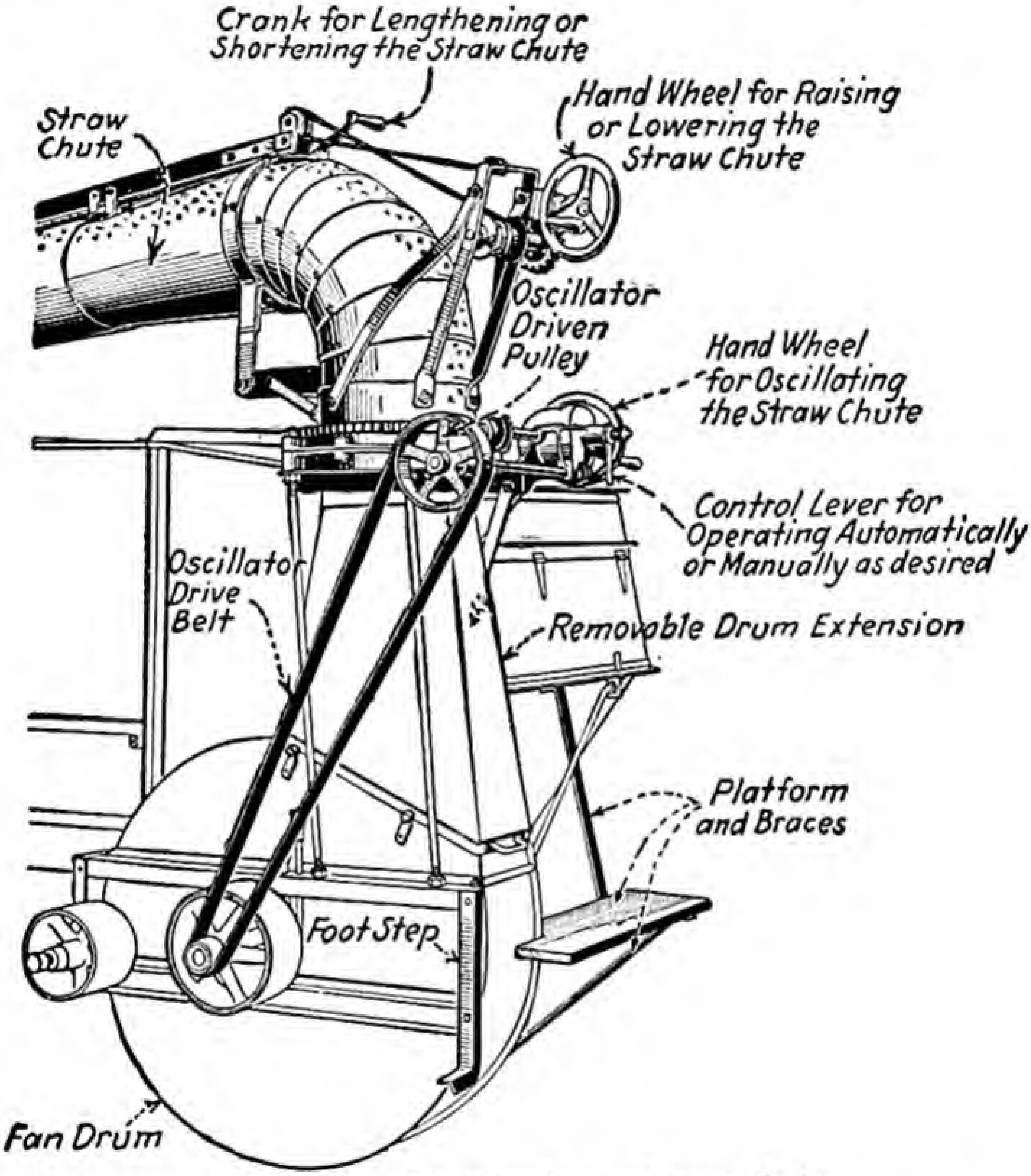


FIG. 559.—Wind stacker and straw chute.

If the machine is lower in front than in the rear, the grain, chaff, and straw may be retarded, causing the conveyor to choke.

Under some conditions a thresher will do slightly better work if set lower at the rear than at the front, but most threshers will operate best when sitting level. If the thresher is not sitting level crosswise, the grain may overload the sieve on the side which is lower, while the other side will be practically clear. When such conditions prevail, it is difficult to adjust the sieve to do a good cleaning and separating job.

In the setting of any machine, the direction of the prevailing wind should be considered. Generally, it is best to set a thresher quartering with the wind than it is to set it in direct line. This is especially true when steam tractors are used. It reduces the danger of fire from sparks of the engine; then, too, the men do not have so much dirt to work in. It also helps in the feeding.

PEANUT THRESHERS, PICKERS, AND COMBINES

The method of gathering peanuts from the vine after they have been dug and cured is a very slow and tiresome process unless improved machinery is used. The primitive way of gathering them from the vine was picking them by hand. The average picker, when picking by hand,

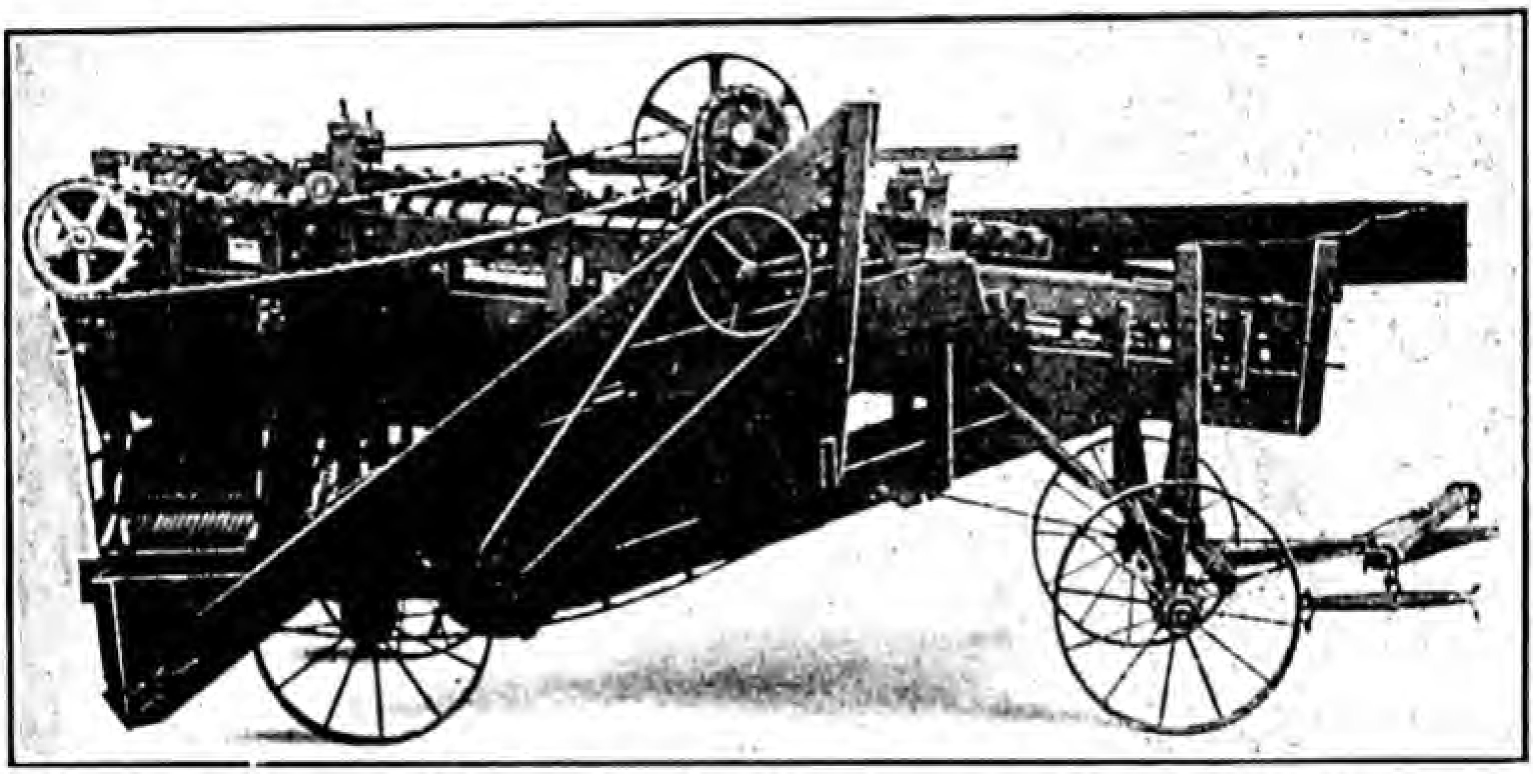


FIG. 560.—Peanut picker equipped with recleaner and bagging attachment.

can pick only about 8 to 12 bushels per day. With the scarcity of labor and the improvement of peanut-picking machinery, hand picking has largely been displaced by machinery in the peanut-growing sections. Three types of machines are used for removing peanuts from the vines: the thresher, the picker, and the combine.

472. Peanut Thresher.—The peanut thresher is a cylinder-type machine similar to the regular grain thresher in all respects with the exception of size and a few other minor changes. The vines are fed into the cylinder where the cylinder teeth jerk the vines between the concave teeth, thus threshing the pods of peanuts from the vines. The cylinders and concaves of some peanut threshers are equipped with spring-wire fingers instead of regular thresher teeth (Fig. 561).

The vines are then carried back over the straw racks, where they are sifted and worked back into the stacking apparatus. One objection to this type of machine is the tendency to break the pods, shelling and

injuring the peanuts. It is necessary to run the cylinder rather slowly to overcome this tendency. About 400 r.p.m. is the average speed.

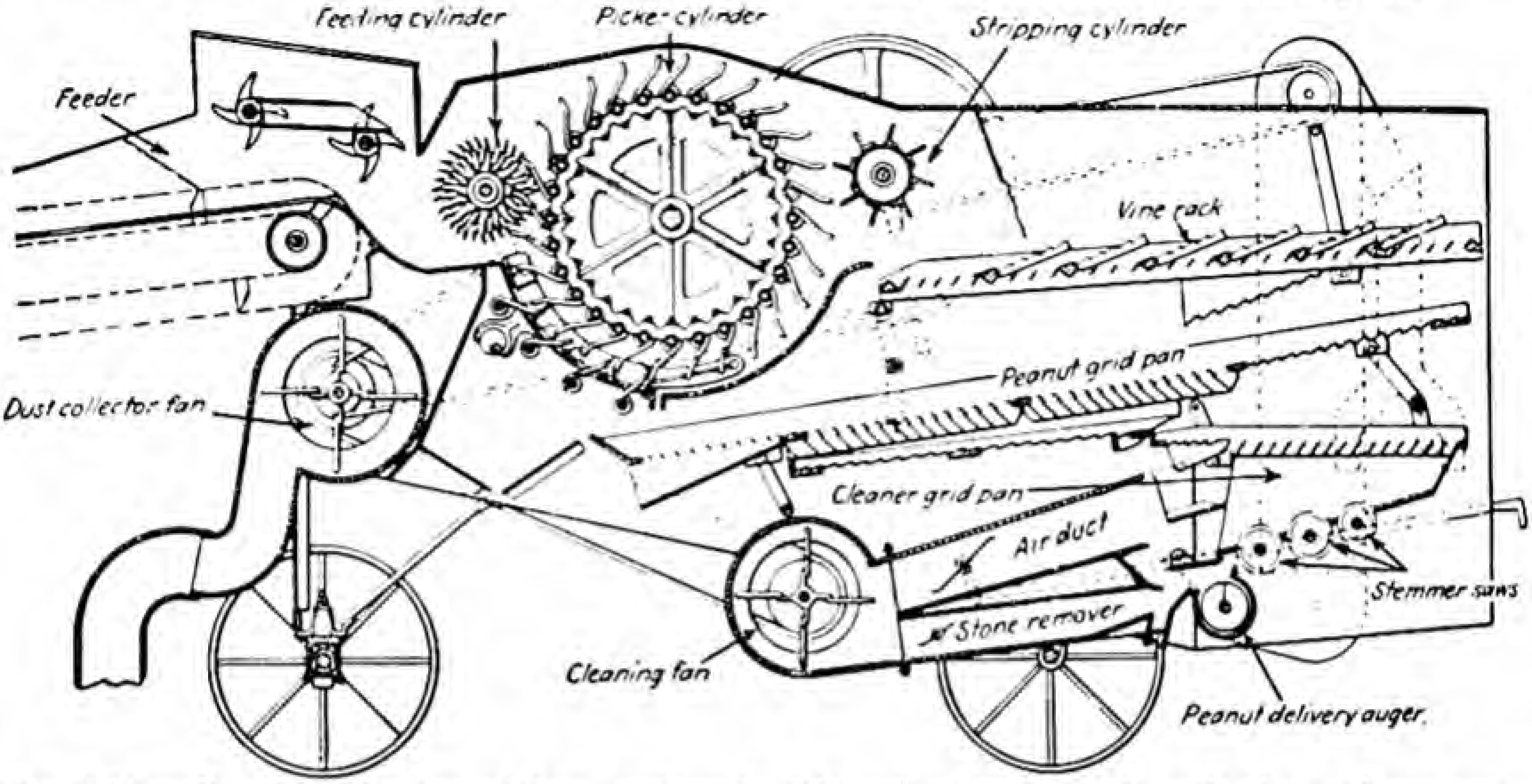


FIG. 561.—Peanut thresher-picker equipped with spring teeth on the cylinder and concaves.

473. The Peanut Picker.—The other type of picking machine, which differs materially in principle from the cylinder machine, is shown in Fig. 560. The picking is done by dragging the vines over a wire-mesh screen in such a way that the nuts fall through and are brushed off from the lower side. There is practically no tendency to break and injure the pods. As very little power is required for operation, the 5- or 6-horsepower gasoline engine is sufficient. These machines are easily provided with attachments for cleaning and removing the small stems from the pods and turning out a better grade of nut. The capacity of this type of machine depends upon the design and the condition of the peanuts, about 250 bushels per day being an average.

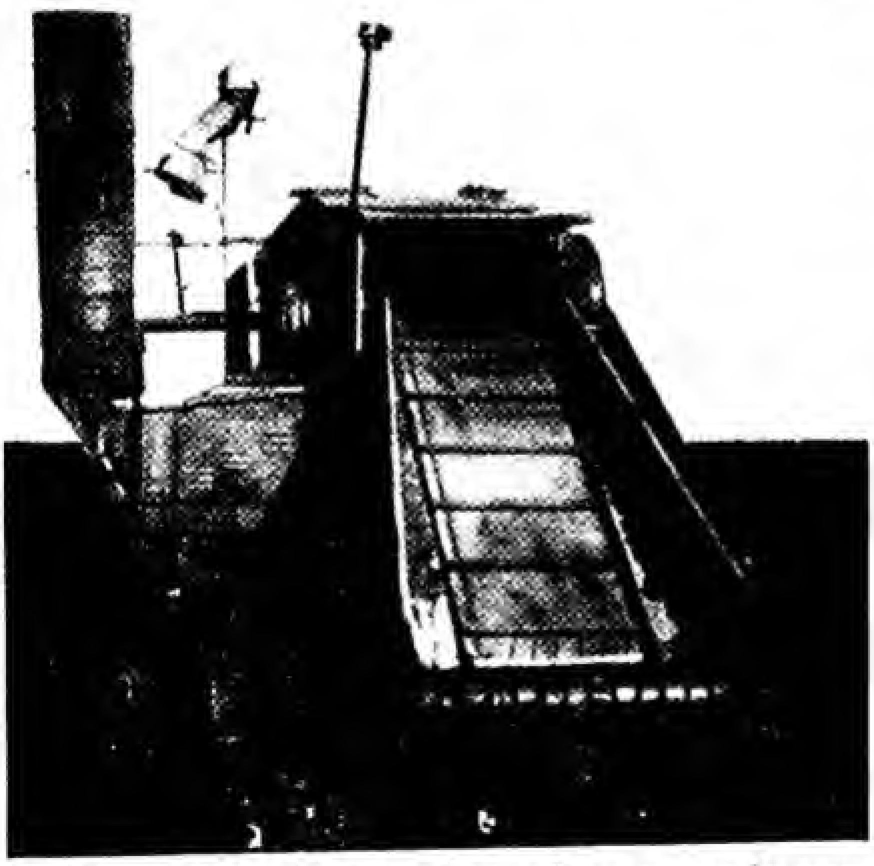


FIG. 562.—Front view of homemade peanut pickup combine. Note the large air-intake pipe for engine radiator at left.

474. The Peanut Combine.—Improved methods of digging peanuts with tractor attachments and the windrowing of the vines have led both farmers and manufacturers to try threshing the peanuts from the vines with combines. These machines are still in the experimental stage, but they should be perfected soon. Most peanuts

are dug, windrowed, and allowed to cure before they are threshed. It is thought by some that it is possible to dig the peanuts and run them on through the threshing unit as a continuous operation; then they can be dried with a mow or barn-type drier. Where rains fall on the windrowed peanuts and they become wet severe losses result. Farmers of South Texas have successfully dried peanuts both in bulk and in the sack.

Figure 562 shows a peanut pickup thresher made by mounting a standard peanut thresher on a trailer frame and making a special pickup attachment. The thresher is operated by an auxiliary engine but is pulled along the windrow with a tractor.

COMBINES

The combined harvester-thresher or *combine* heads the standing grain, threshes it, and cleans it as it moves over the field. Therefore, it takes the place of and eliminates from the harvest the grain binder, the header, the stationary thresher, and the tiresome tasks of shocking or stacking the grain and hauling the bundles.

The combine is adapted to harvesting all the small grains, soybeans, grain sorghums, rice, and many other crops.

475. Types.—There are two general types of combines, the *pull* or *tractor-drawn* and the *self-propelled.* Combines are also referred to as *straight-through* and *platform* combines.

The *straight-through* combine is designed so that the cutting unit is directly ahead of the threshing unit and the grain is carried straight back from the cutter bar into the threshing unit.

The *platform*-type combine has the cutting mechanism to one side; the grain is carried across the platform, then elevated into the threshing unit.

The Pull-type Combine

The pull-type combine is drawn by a tractor. The smaller combines are driven from the power-take-off of the tractor (Fig. 563), while the

Fig. 563.—Small combine harvesting soybeans.

larger sizes have an auxiliary engine mounted on the combine to drive it (Fig. 564).

Pull-type combines range in size from a 4 to 8-foot cut for the smaller sizes and from a 10 to 20-foot cut for the larger sizes. Gatherers at each end of the cutter bar enable the average machine to cut a swath from 6 to 9 inches wider than the actual length of the cutter bar.

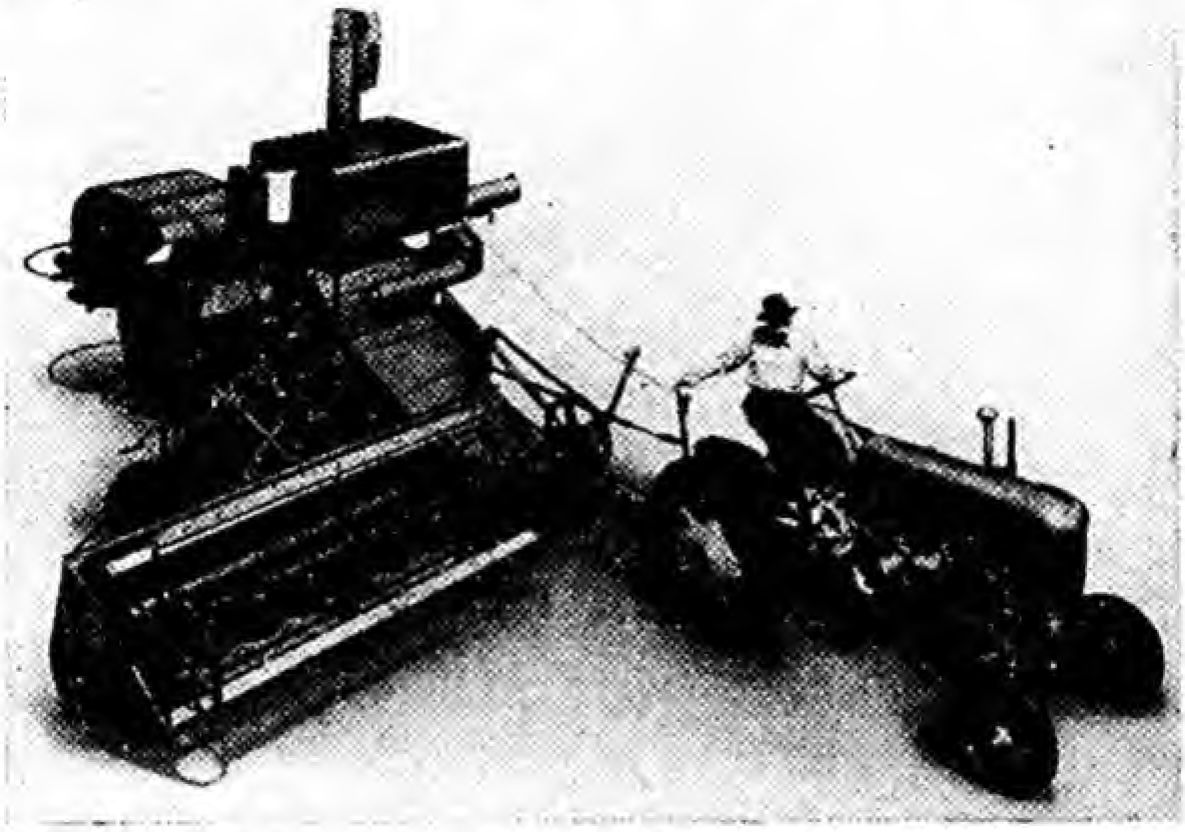


FIG. 564.—Pull-type combine equipped with auxiliary engine.

476. The Cutting and Feeding Mechanism.—The cutting and feeding mechanism includes the various parts that make up the cutter bar, the reel, and the devices that convey and feed the grain to the cylinder and concaves of the threshing unit.

If the grain has been windrowed, a pickup device is attached to the platform in front of the cutter bar (Fig. 565), which may be either power-driven or ground-driven.

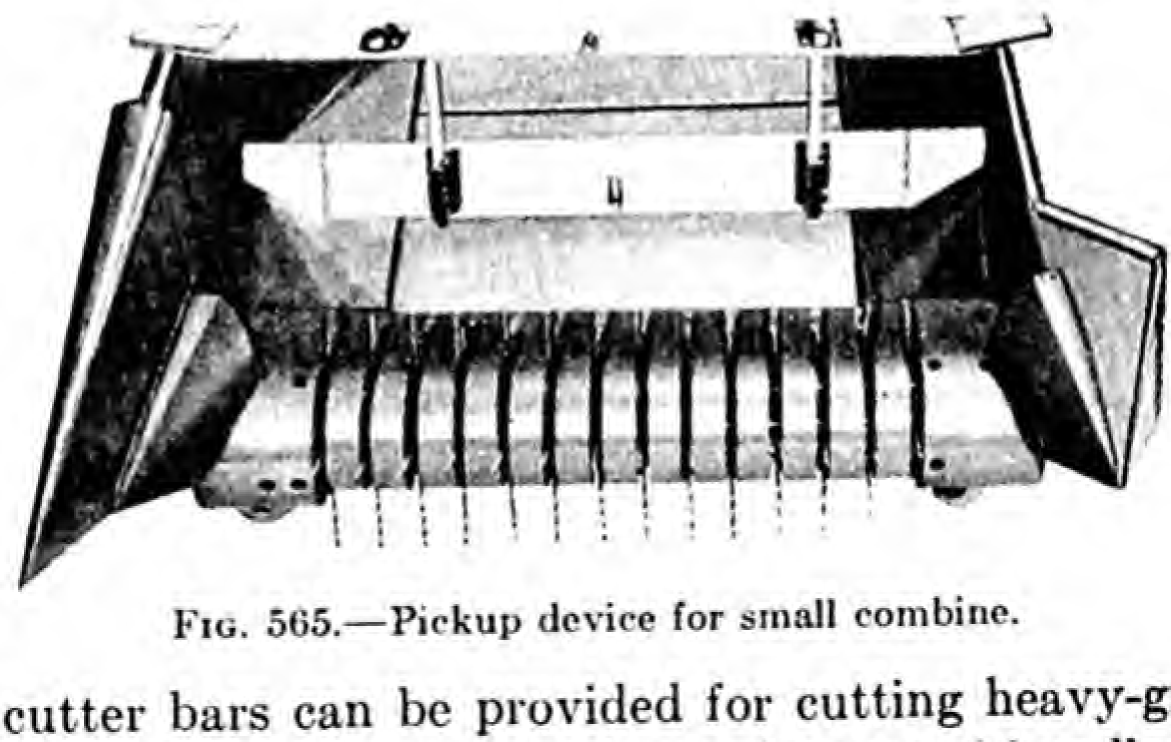


FIG. 565.—Pickup device for small combine.

Special cutter bars can be provided for cutting heavy-growth crops and for cutting the heads from previously harvested bundles (Fig. 566). Grain lifters can also be attached for picking up down grain.

On the small combines the grain is usually elevated directly into the threshing unit by elevator and feeder canvases. Large combines with

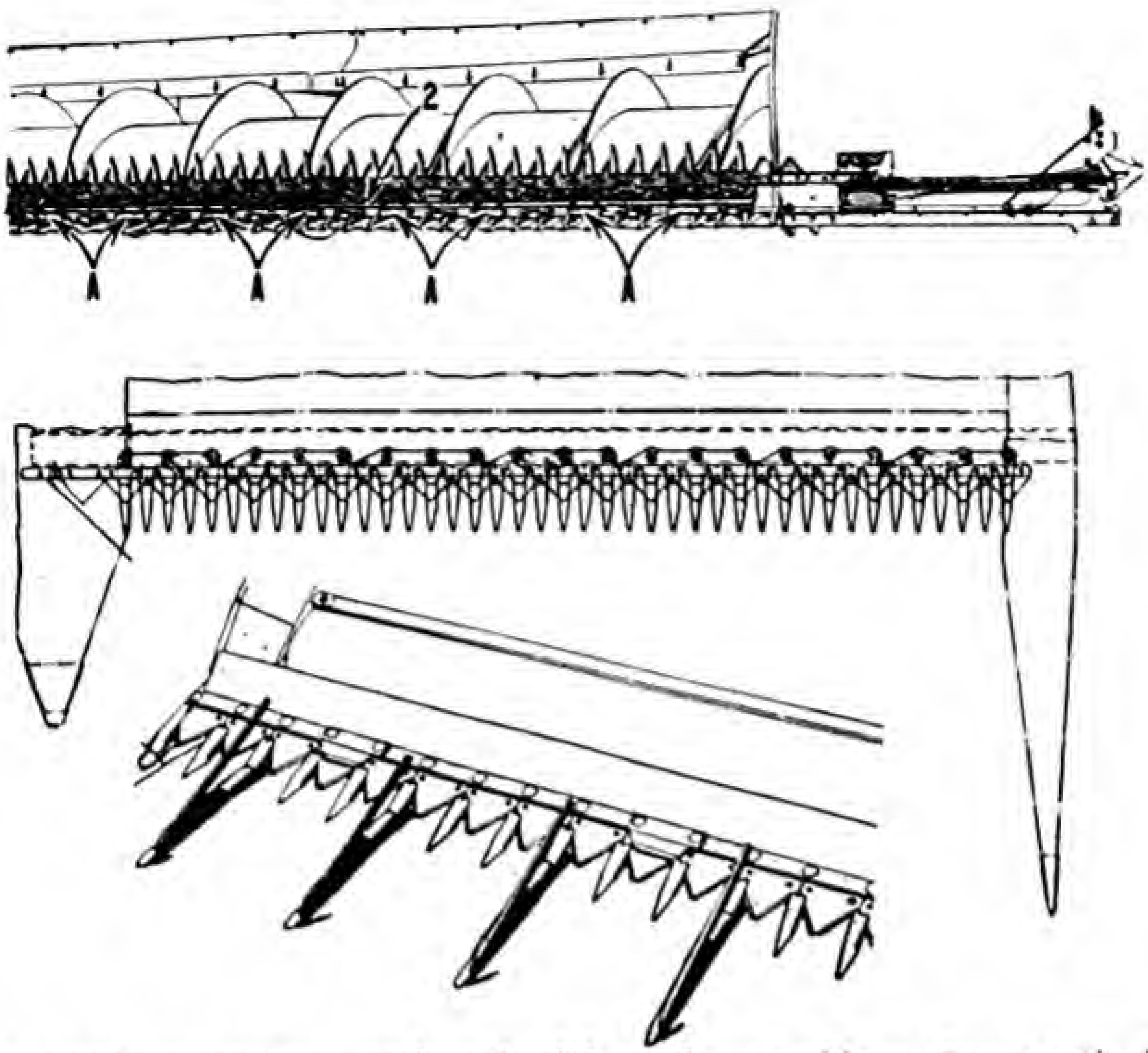


FIG. 566.—Special cutter bars and grain lifters for combines: *top*, vertical cutter bar; *center*, Lespedeza bar; *bottom*, grain lifters.

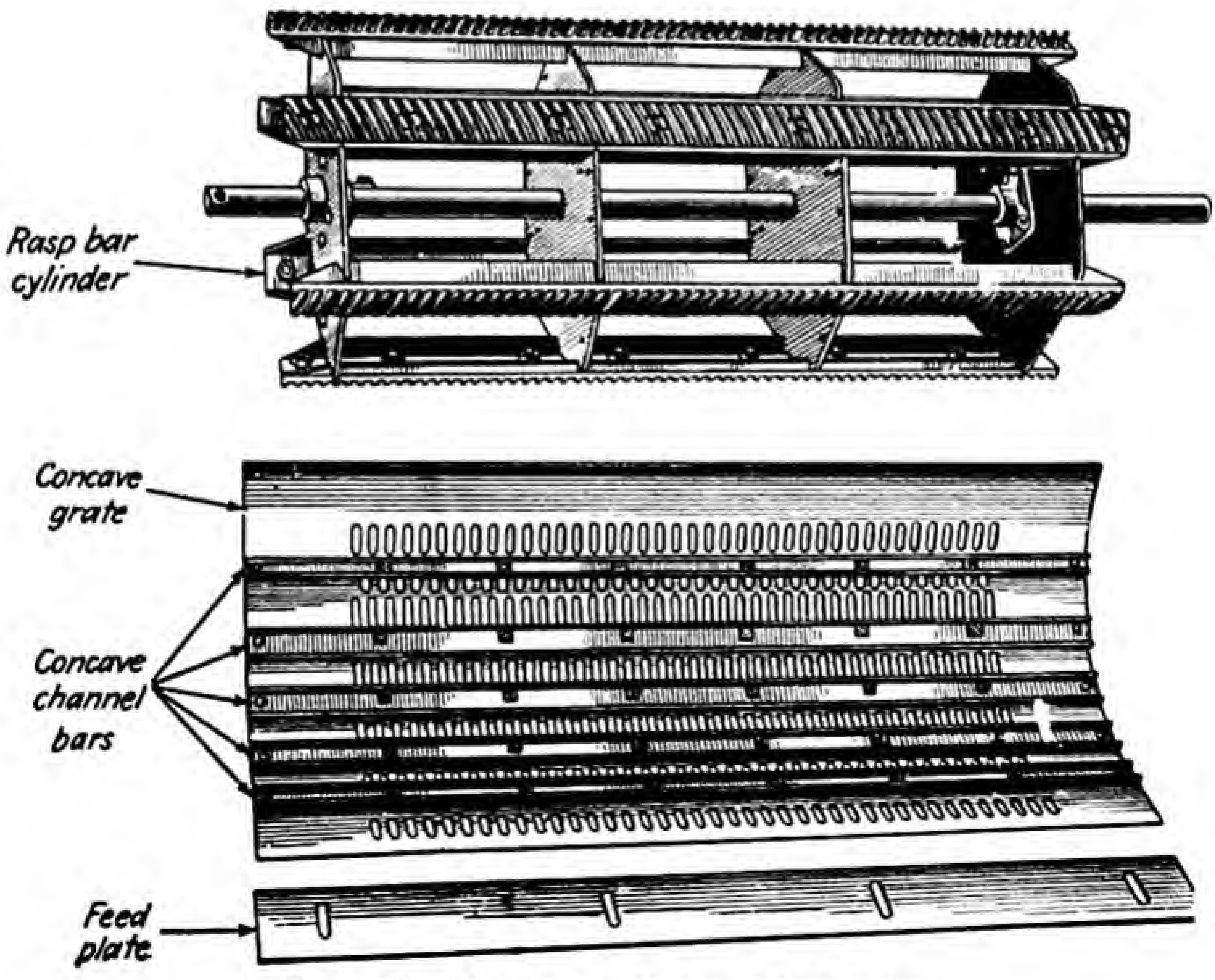


FIG. 567.—Rasp-bar cylinder and concaves.

long cutter bars and platforms generally use a large auger to slide the grain along the curved sheet-steel platform and deliver it to an elevator, which feeds the grain into the threshing unit (Fig. 564).

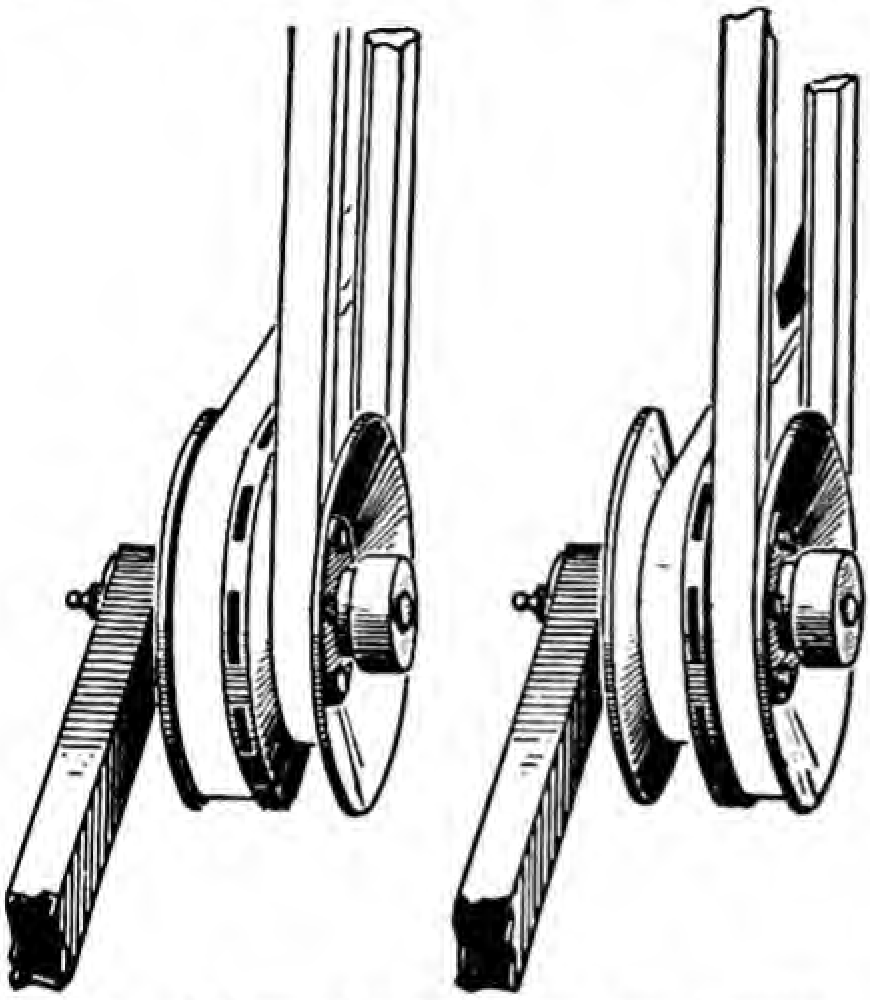


FIG. 568.—Adjustable pulley sheaves, showing how speed of cylinder can be changed. Slow-speed adjustment on left and high-speed on right.

477. Threshing Mechanism.—The grain is fed into the cylinder and concaves by upper and lower feeder canvases. The larger combines have a beater-feeder to aid in feeding the grain. Most combines use the rasp-bar type of cylinder and concaves (Fig. 567). Adjustments are provided for varying the speed of the cylinder to suit the kind of crop being harvested. V-belt drives are used on most combines (Fig. 568).

478. Separating and Cleaning Mechanism.—The separating and cleaning mechanism of a combine is quite similar to that of a regular stationary thresher. The principal difference is in the size. Naturally, a 4-foot combine does not handle nearly the volume of straw and grain

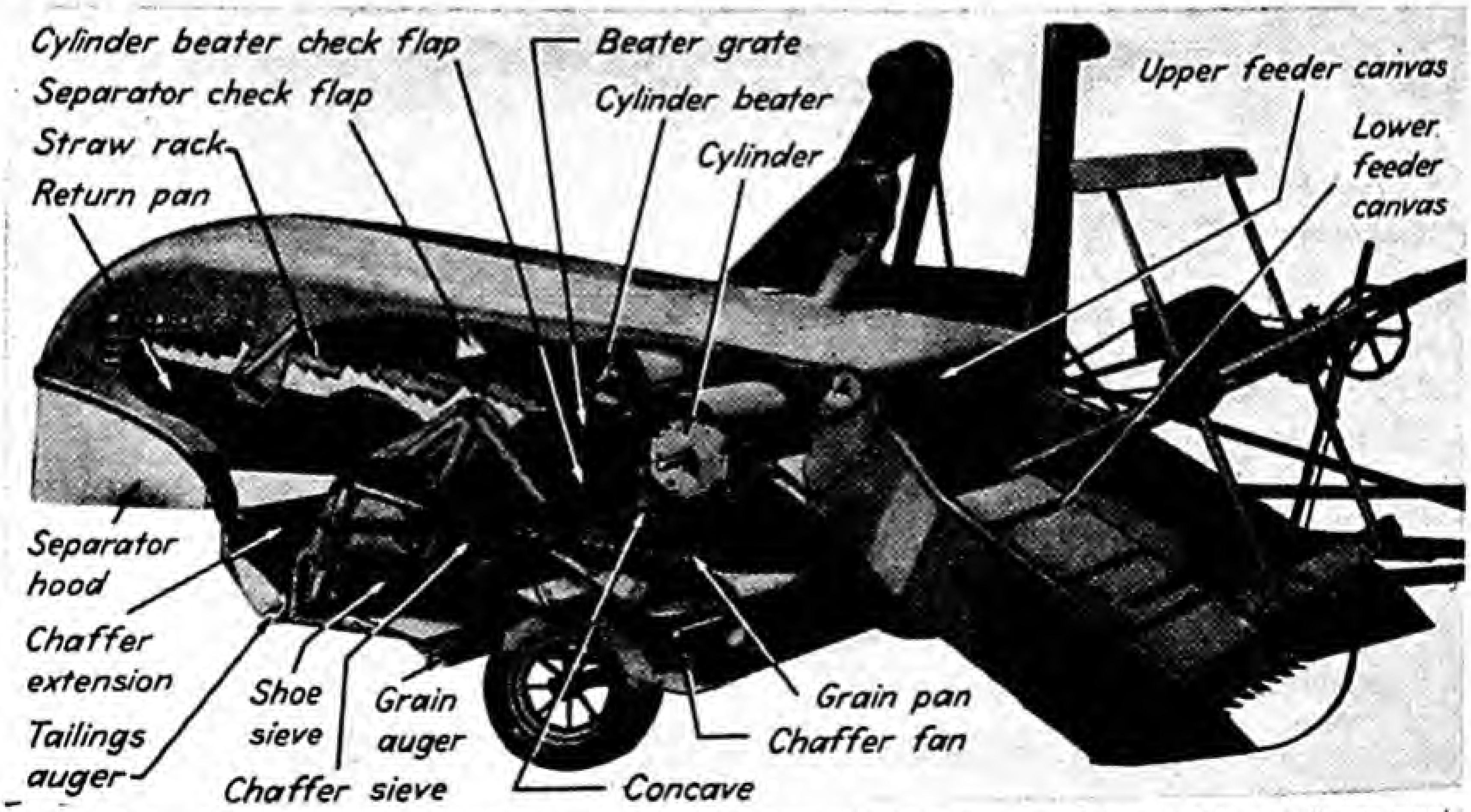


FIG. 569.—Cutaway view of small power-take-off-driven combine with various parts indicated and named.

that a 6- or 8-foot combine does; therefore, the separating and cleaning units are designed to handle the average volume of grain in accordance

with the width of swath harvested. Figures 569 and 570 show typical designs for combine separating and cleaning mechanisms.

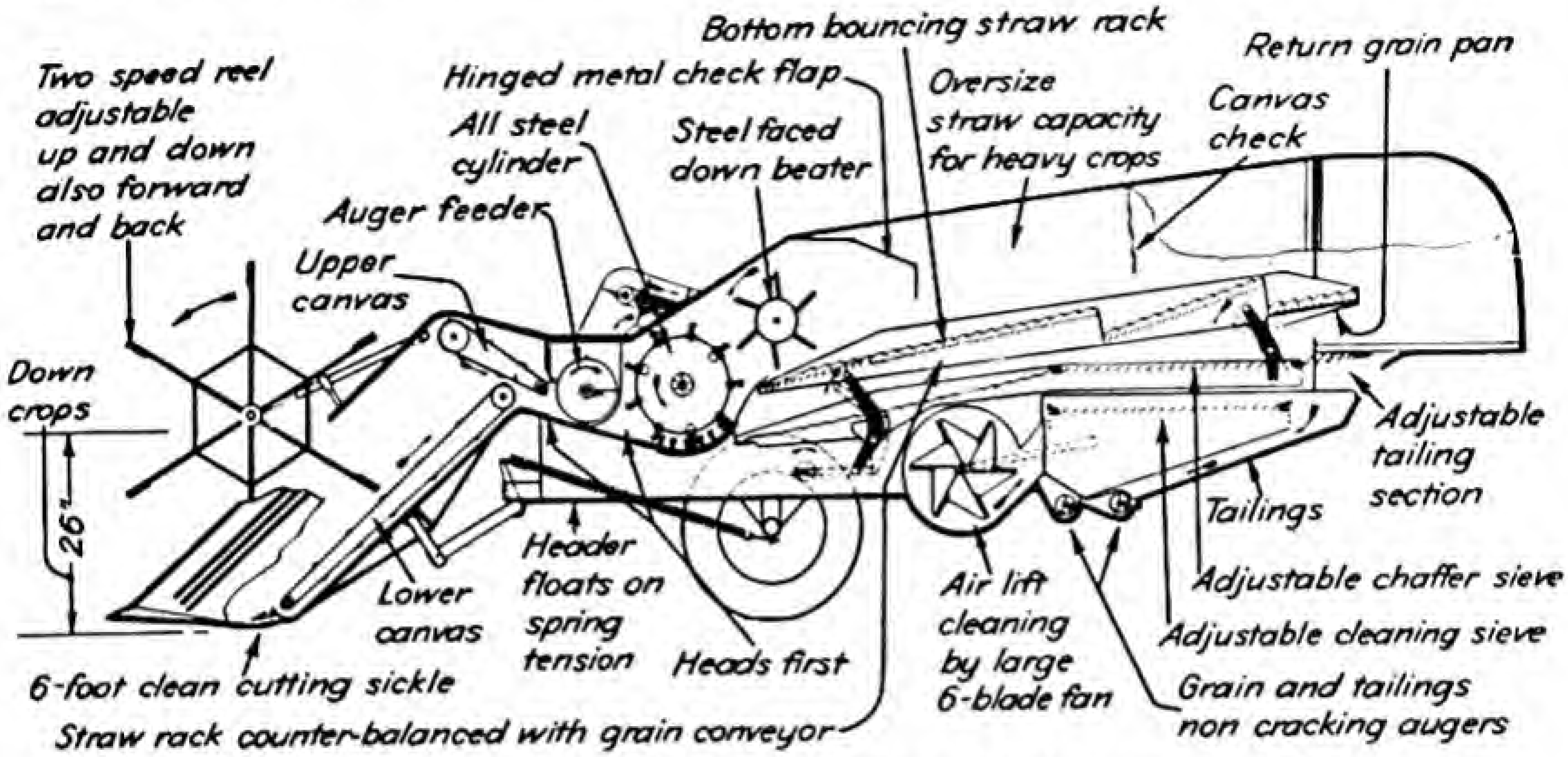


FIG. 570.—Cross-sectional view of combine showing various parts.

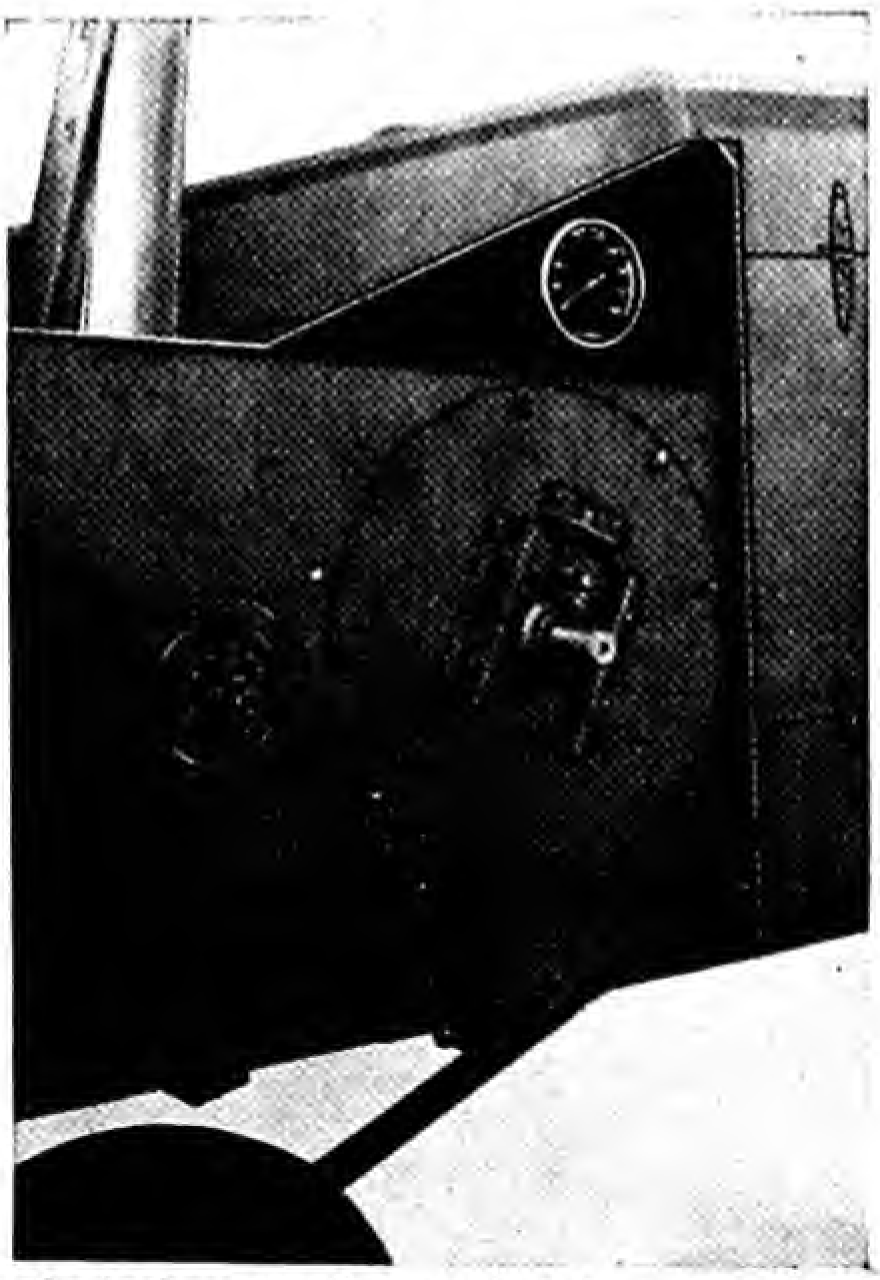


FIG. 571.—By means of a tachometer the speed of the cylinder can be determined at any time.

479. Attachments for Combines.—A number of attachments can be obtained for combines. These include a straw spreader, straw wind-

rower, straw loader, windrow pickup, windrow spreader, bundle topping vertical cutter bar, flax roller, bagger, grain bin, cylinder speed tachometer (Fig. 571), and a "scourkleen" for the removal of weed seeds (Fig. 572).

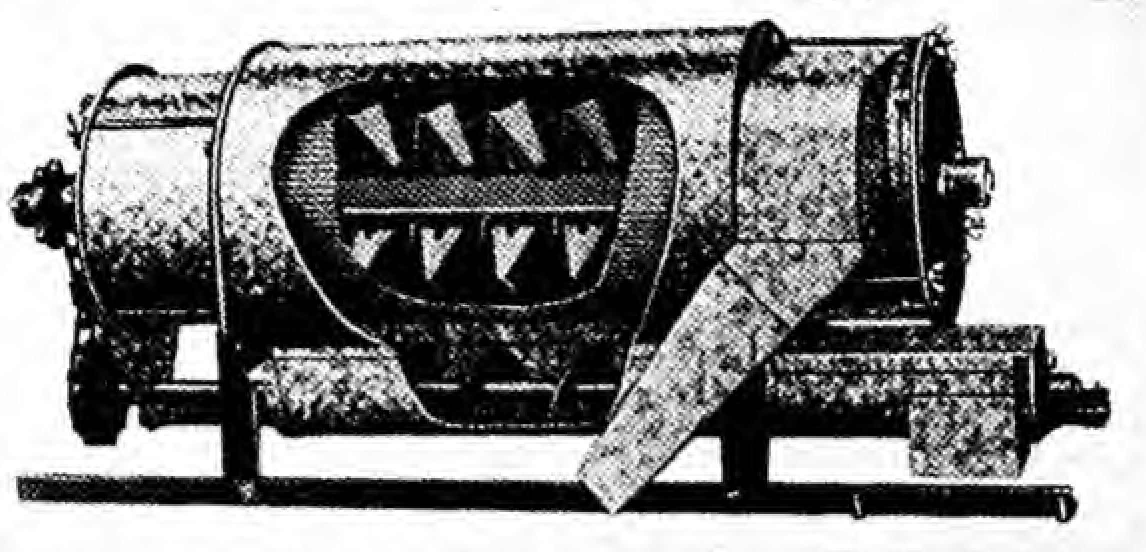


FIG. 572.—A "scourkleen" attached above the grain bin or bagging attachment cleans weed seed from grain.

THE GRAIN SELF-PROPELLED COMBINE

Self-propelled combines are powered with industrial-type engines of 45 to 60 horsepower. The self-propelled combine is operated by one man. It is easy to handle and transport from field to field and over the highway. A swath can be laid out without loss of grain. Sharp turns

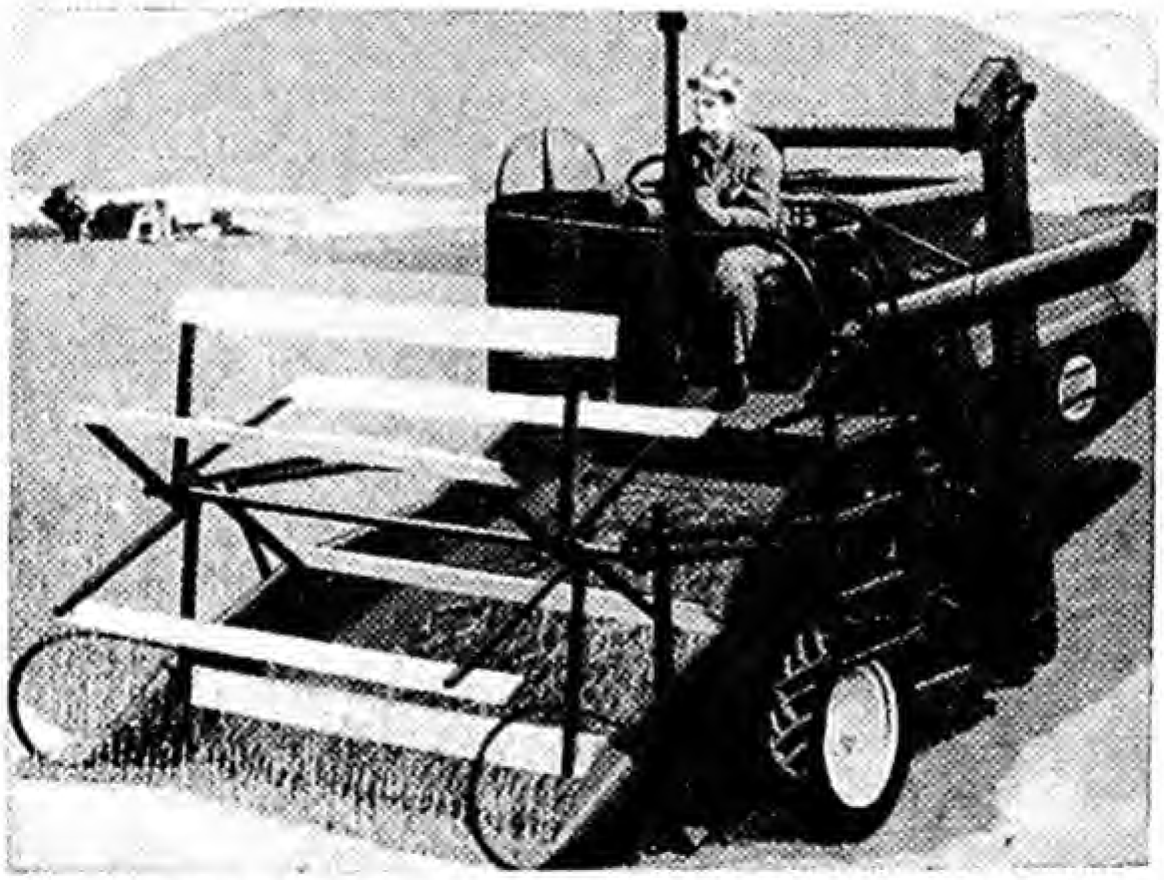


FIG. 573.—Small 6-foot grain self-propelled combine.

can be made to follow rice levees. It is provided with a gear shift to give desired field and road speeds. There is also a reverse gear.

Grain self-propelled combines may be obtained in sizes to cut swaths from 6 to 14 feet (Figs. 573, 574, and 575).

480. Operation.—The operator of the self-propelled combine sits above and just behind the electrically or hydraulically controlled plat-

form (Fig. 576). The general operation is somewhat like that of a tractor. The machine is steered by means of a large steering wheel connected to the wheels in the rear. If sharp or right-angle turns are to be made, wheel brakes assist in making the turn, similar to the general-

FIG. 574.—Self-propelled combine harvesting soybeans.

purpose row-crop tractor. The engine can be started by pressing a button, which actuates the self-starter. Transmission and separator clutch levers are conveniently located to control machine travel and operation (Fig. 577). A slight movement of a lever on the steering post enables the operator to raise and lower the platform to meet changing

FIG. 575.—Self-propelled combine harvesting oats.

conditions in the field. Field speeds range from $1\frac{1}{4}$ to 4 m.p.h., while road speeds range from $2\frac{1}{2}$ to 13 m.p.h. No changes need to be made in the machine for short-distance transportation over highways other than raising the platform and shifting into road gear.

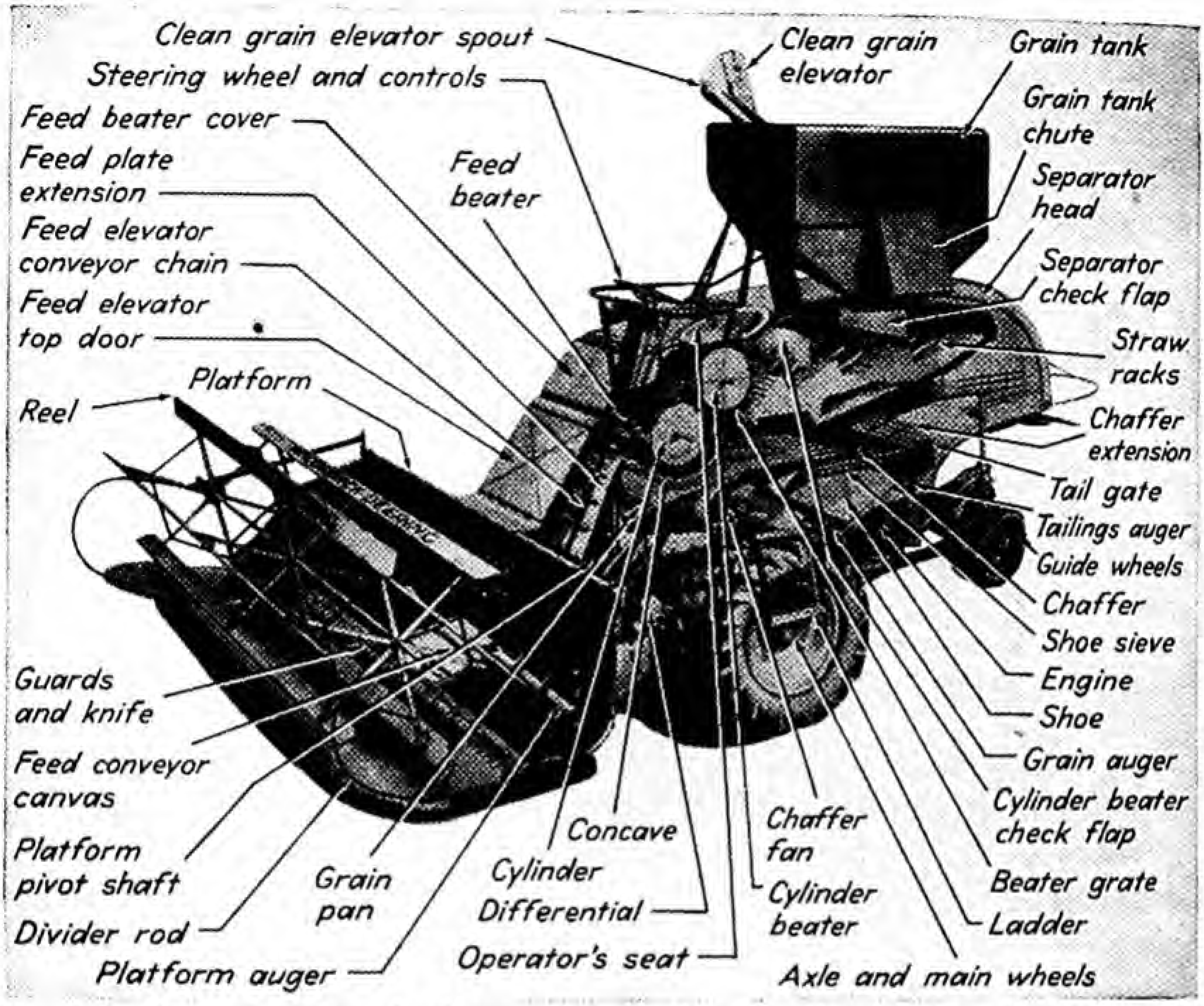


FIG. 576.—Cutaway view of self-propelled combine showing location of various parts. Engine has been removed to show interior parts.

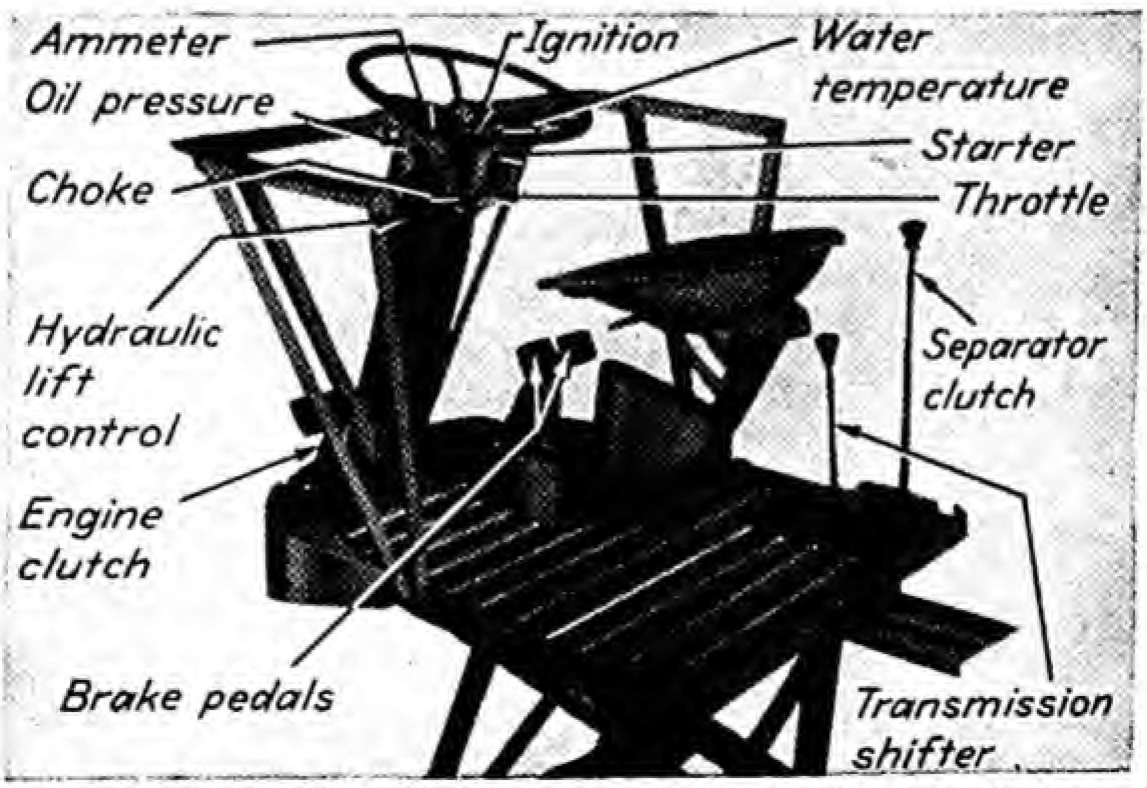


FIG. 577.—Operator's deck and controls for a self-propelled combine.

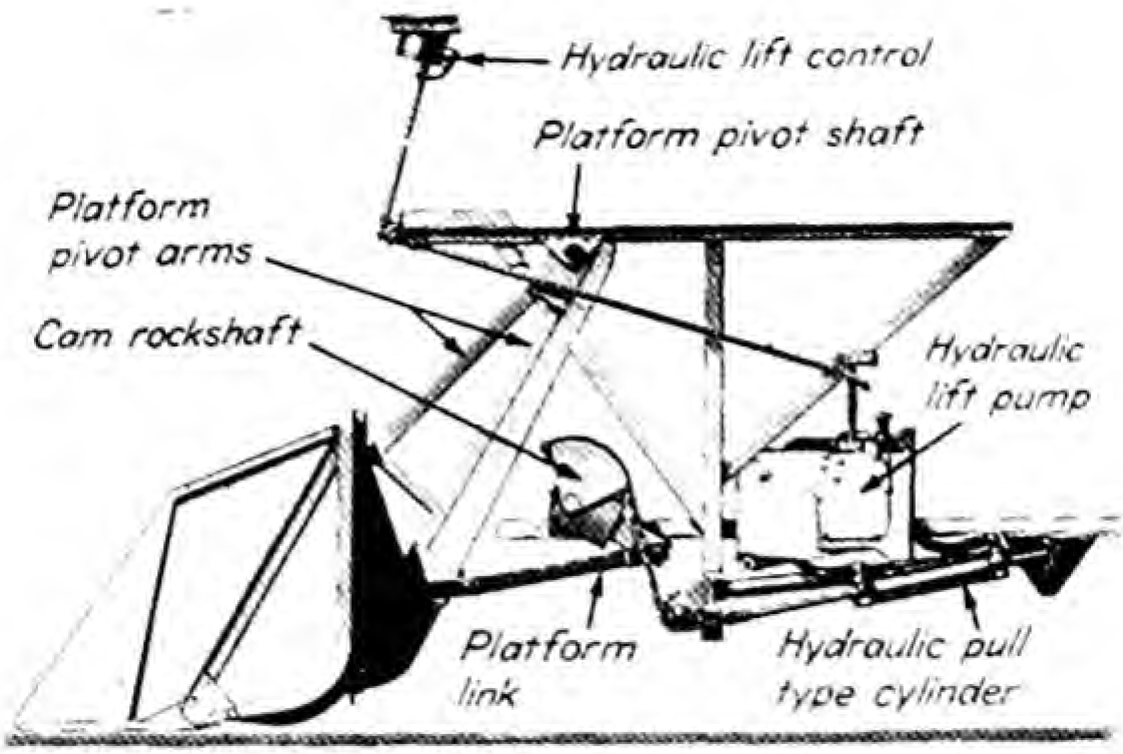


FIG. 578.—Hydraulic lifting arrangement for platform of a self-propelled combine.

481. The Cutting and Feeding Mechanism.—On the small self-propelled combine the cutter bar and elevator feeder arrangement are very much like the arrangement used on the pull-type combines (Figs. 563 and 573). On the large machines where the cutter bar is 12 or 14 feet in length, right- and left-hand open-end augers deliver the grain to the cylinder feeder located in the middle of the platform (Fig. 579).

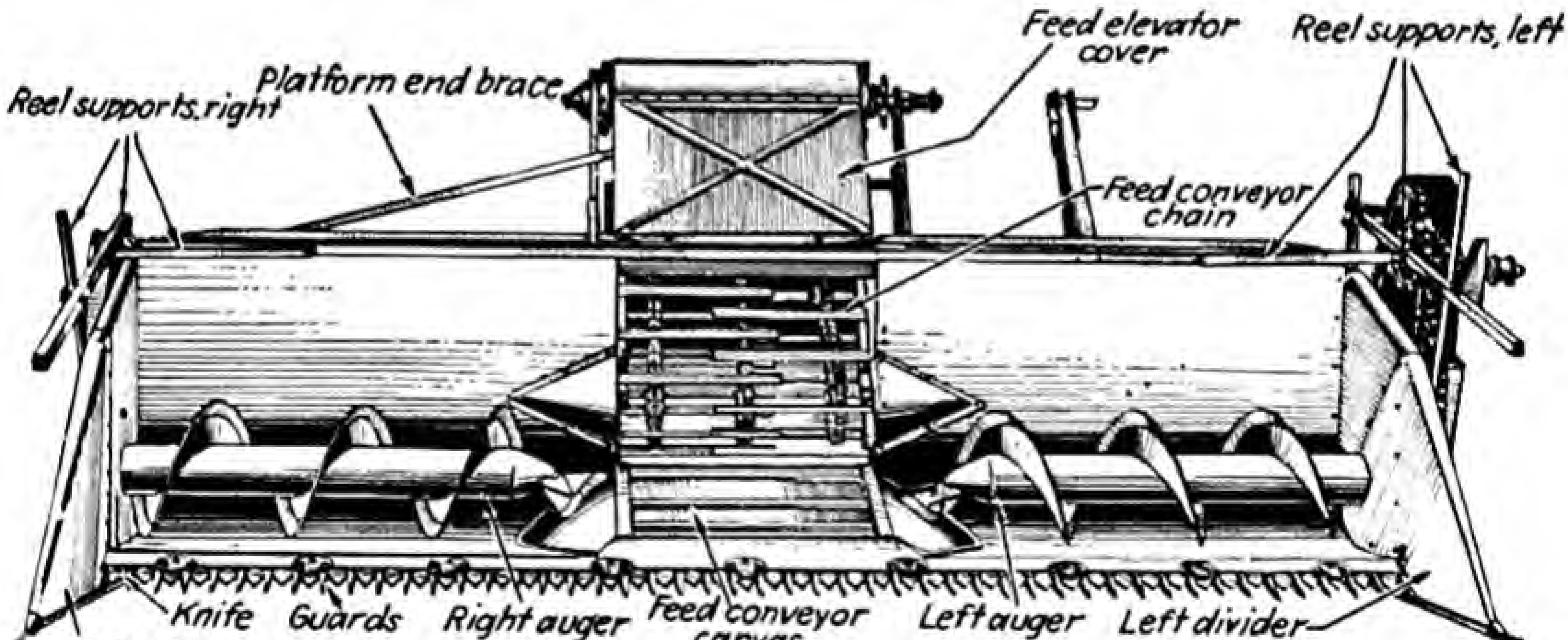


FIG. 579.—Front view of platform and feeder mechanism for a 14-foot self-propelled combine.

Well-constructed six-bat power-driven reels can be adjusted to bat the grain back onto the platform (Fig. 580).

The long sickle or knife is moved back and forth by a rocker-arm arrangement (Fig. 581).

The windrow pickup attachment may extend the full width of the cutter bar on small combines but extends only across the middle of the cutter bar on the large machines.

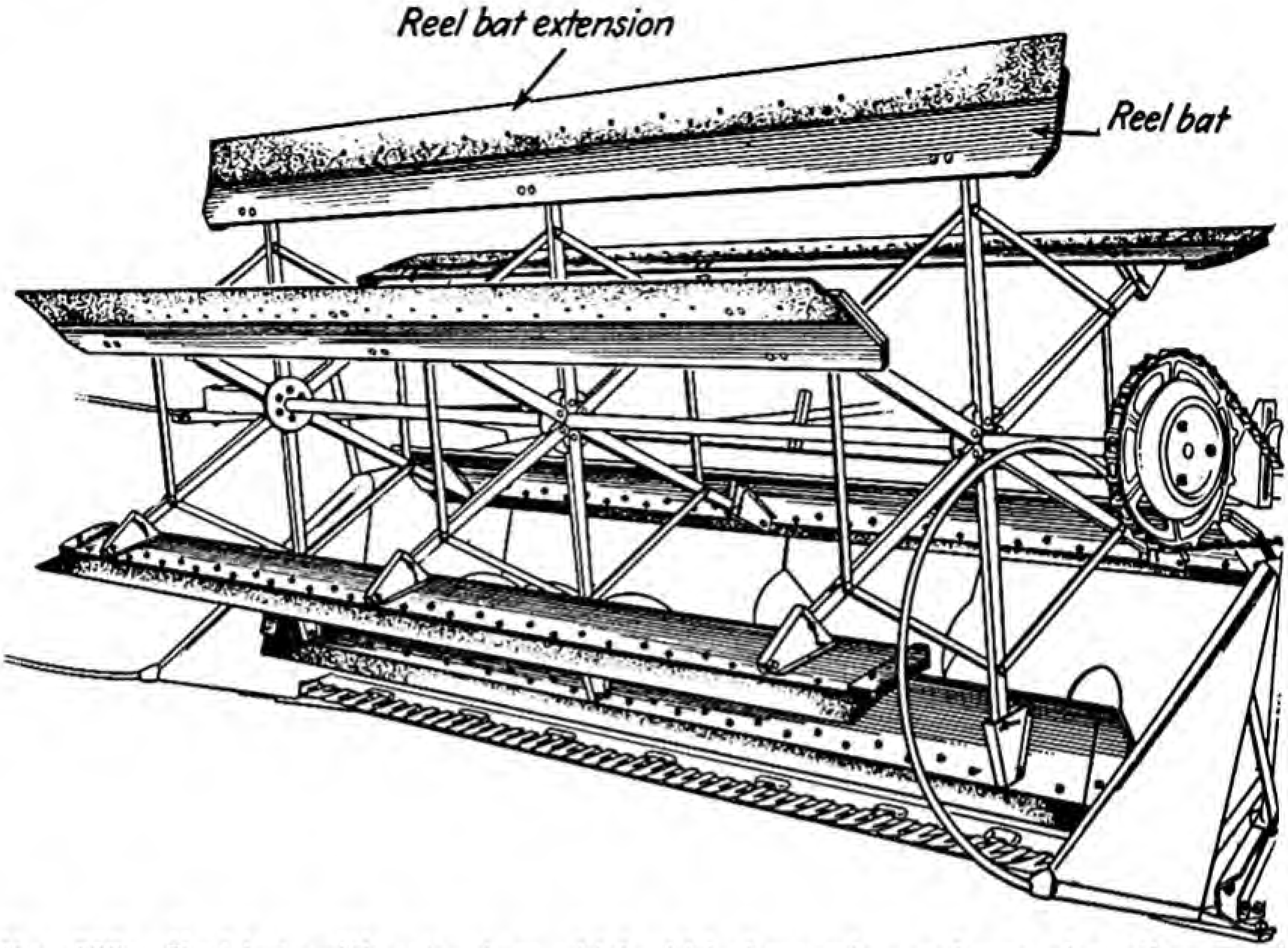


FIG. 580.—Reel bats with extensions which aid in harvesting soybeans, rice, other special crops, and where there are vines.

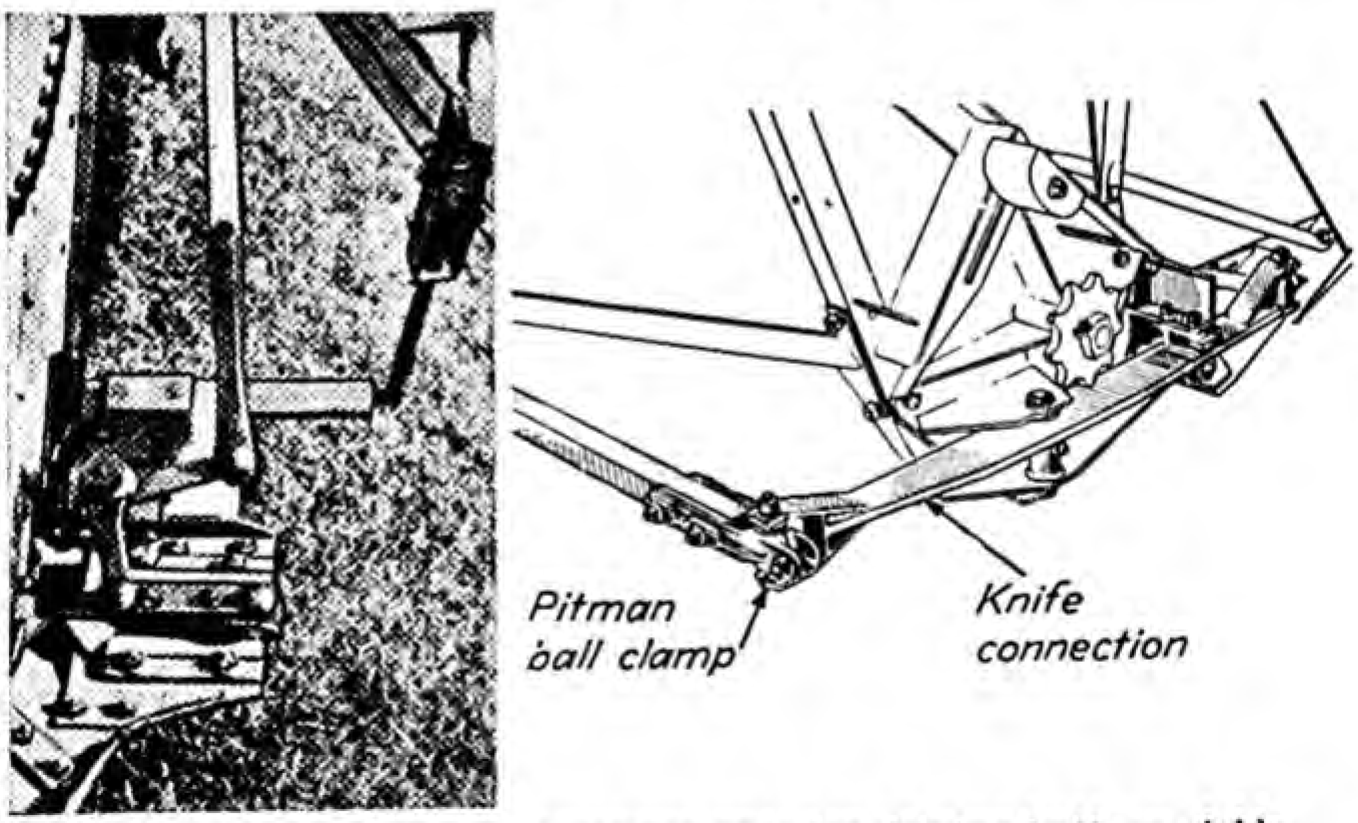


FIG. 581.—Rocker-arm arrangements for driving knife or sickle.

482. Threshing Mechanism.—The threshing mechanism of the self-propelled combine does not differ from that on pull-type combines. Special feed-beaters may be used. Rasp-bar cylinder and concaves are used on most self-propelled combines.

483. Separating and Cleaning Mechanism.—This mechanism is similar in construction and operation to that found on other types of combines.

484. Attachments.—The attachments listed for pull-type combines are used also on the self-propelled combines.

THE RICE SELF-PROPELLED COMBINE

If the details of the machines shown in Figs. 574, 576, and 582 are studied closely, it is seen that the principal differences are in the size

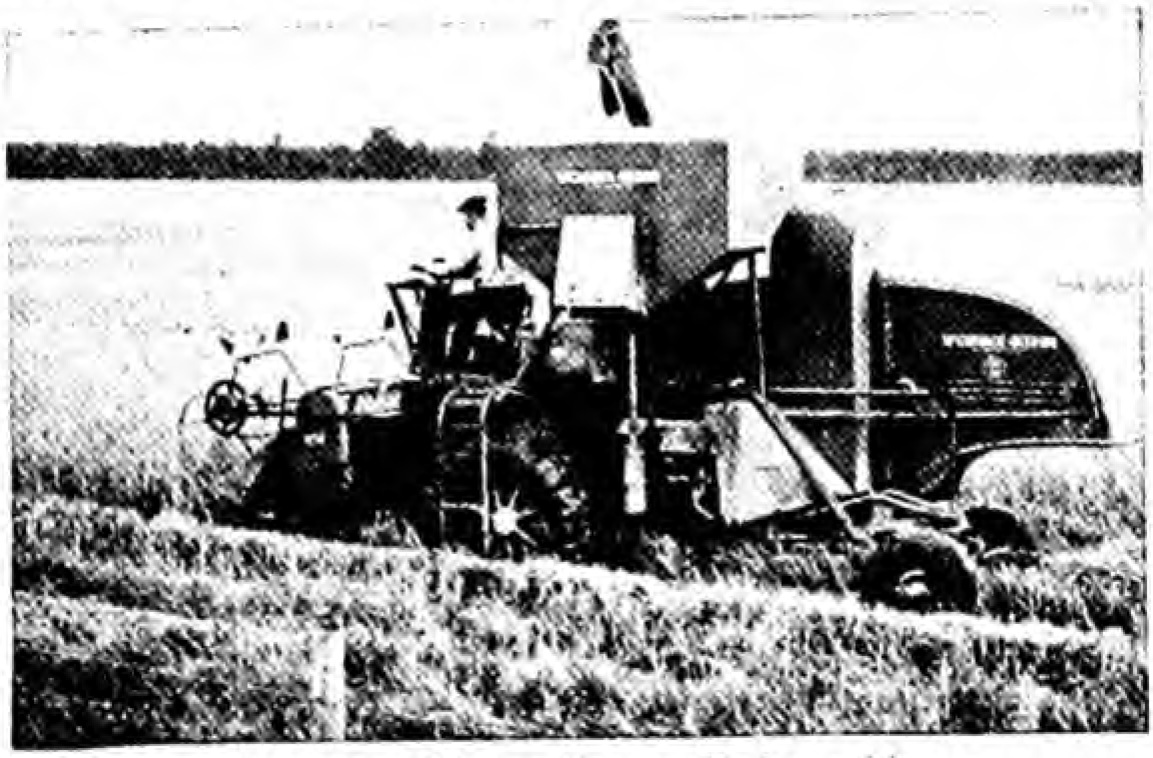


FIG. 582.—Rice self-propelled combine.

and arrangement of the wheels. The regular grain self-propelled combine is supported by dual wheels on each side, equipped with medium-sized tires. The guide wheels are set close together, similar to those on the row-crop tractor. The single main wheels of the rice self-propelled combine are equipped with large deep lugs to enable the combine to

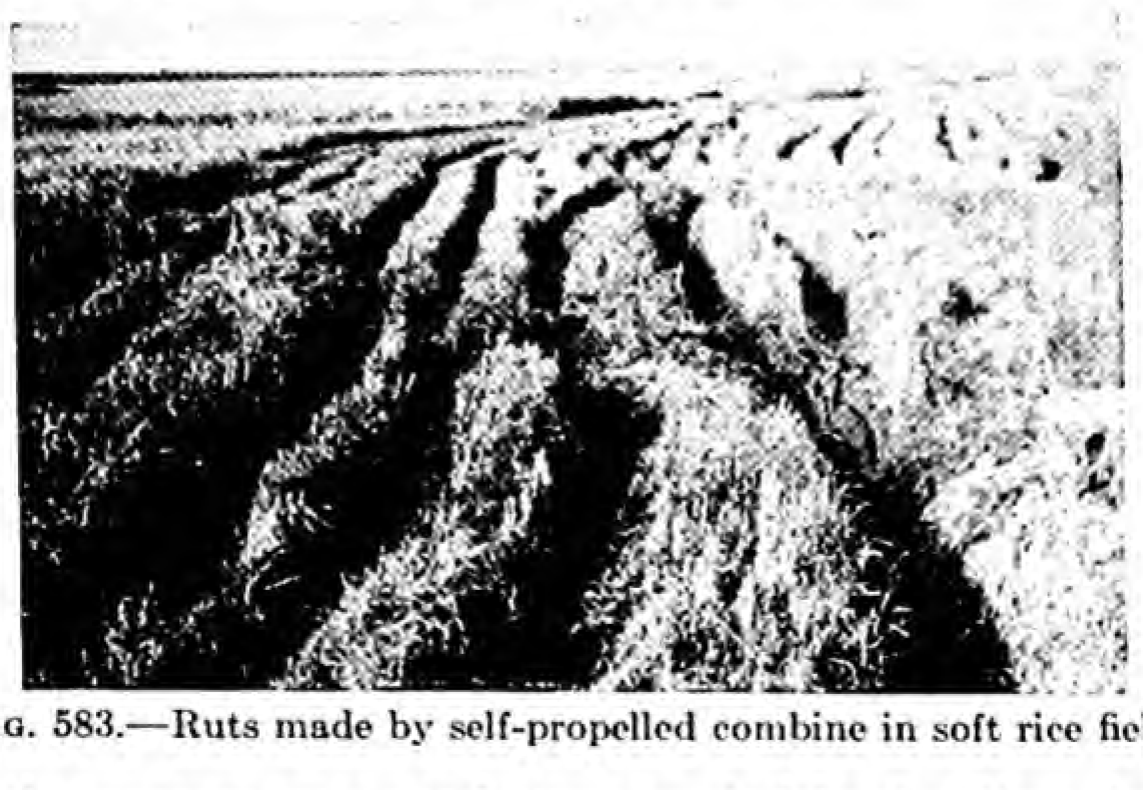


FIG. 583.—Ruts made by self-propelled combine in soft rice field.

climb over the narrow contour levees needed in flooding rice fields and to give traction in muddy, poorly drained fields (Fig. 583). The guide wheels of the rice combine are set wide apart to follow the ruts made by the main wheels. Some rice combines are equipped with track drivers. It is claimed that the track operates better than tires in some soils.

Tires on the combines are more satisfactory for traveling from field to field and for transportation over the highway, as they are faster and do not shake the machine so badly.

The rice self-propelled combine is equipped with an engine of greater horsepower than the grain combine because more power is required to travel over the soft rice fields.

Combines were used extensively in south Texas for the first time in 1943. It is estimated that 60 to 70 per cent of the 1945 rice crop was harvested with combines. The use of the combine has brought about revolutionary changes in handling this crop. Formerly all the rice was handled in sacks; now it is handled in bulk like wheat. Rice carts have been developed to get the rice from the combine out in the wet muddy

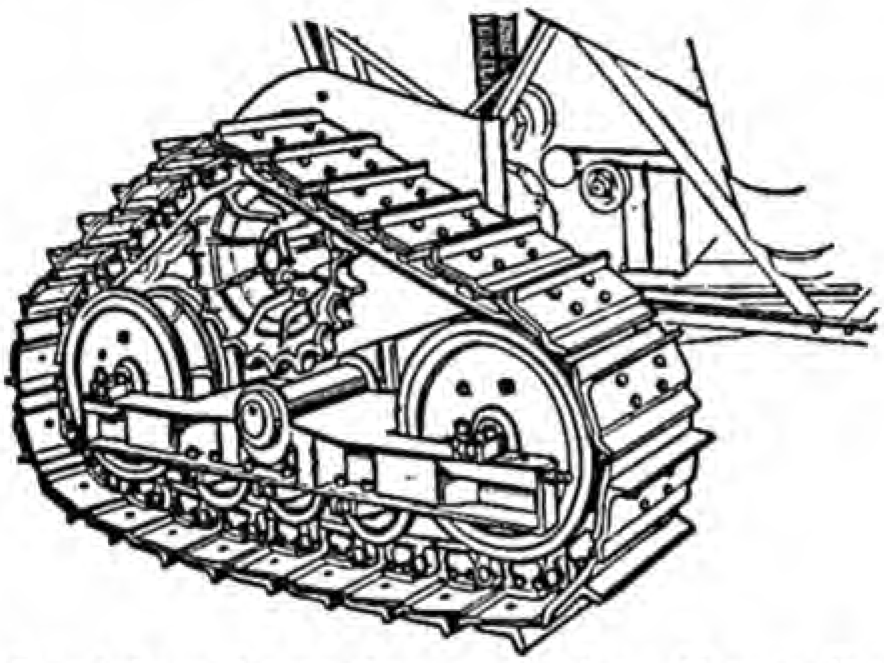


FIG. 584.—Special tracks used on some rice self-propelled combines.

field to a truck located on a graded field road. Furthermore, when rice is harvested there is too much moisture in it for it to be stored and consequently it must be dried. There are now many large commercial rice driers throughout the Gulf coast rice-growing region.

485. Advantages of the Combine.—In comparison with other methods of harvesting and threshing, as reported by farmers, the advantages are[1]

1. The saving in harvesting and threshing costs.
2. The decreased labor.
3. The elimination of hired help.
4. The earlier clearing of the field for tillage operations.
5. The distribution of the straw on the land.
6. The earlier marketing of the crop.

486. Disadvantages of the Combine.—The disadvantages of the combine are

1. The large investment necessary.
2. The large amount of power required.

[1] *U. S. Dept. Agr. Farmers' Bull.* 1565, 1928.

3. The grain is more likely to be damp.
4. Greater risk to crops from storms and hail.
5. The loss of straw for feed and bedding unless additional labor is expended in collecting the straw after the combine.

487. Cost of Combining.—The various items of cost in harvesting with a combine are operating and fixed costs.

Operating expenses consist of the costs of fuel and lubricants, use of tractor, labor, and repairs.

Fixed charges are for depreciation and interest on investment. Taxes, insurance, and the cost of housing may also be added.

Table XVII shows the various items of cost per acre for both operating expenses and fixed costs for a 10- and 15-foot combine, a 7-foot binder, and a 12-foot header.

TABLE XVII.—CHARGES PER ACRE WITH DIFFERENT HARVESTING METHODS[1]

Item of cost	Per acre charges							
	10-foot combine		15-foot combine		7-foot binder		12-foot header	
	Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
Man labor,[2] man-hours	0.69	$0.41	0.65	$0.39	3.6	$1.80	2.8	$1.40
Horse labor,[3] horse-hours	....	....	....	....	5.9	0.59	4.1	0.41
Tractor	....	0.60	....	0.60				
Fuel,[4] gallon	1.30	0.32	1.43	0.36				
Oil,[4] gallons	0.04	0.03	0.05	0.04				
Grease, pounds	0.06	0.01	0.05	0.01				
Twine,[5] pounds	....	....	....	....	2.0	0.28		
Repairs	....	0.10	....	0.10	...	0.05	...	0.05
Threshing[6]	....	....	....	....	...	1.50	...	1.50
Variable costs	....	$1.47	....	$1.50	...	$4.22	...	$3.36
	Annual charges							
Depreciation[7]	....	$152.00	....	$251.00	...	$22.50	...	$13.33
Interest[8]	....	37.80	....	62.52	...	6.75	...	6.00

[1] *U. S. Dept. Agr. Tech. Bull.* 70, p. 31, 1928.
[2] Labor on combines charged at 60 cents per hour; on binders and headers at 50 cents per hour.
[3] Horse labor charged at 10 cents per hour.
[4] Fuel charged at 25 cents, oil at 75 cents per gallon.
[5] Twine charged at 14 cents per pound.
[6] Threshing charged at 10 cents per bushel; 15-bushel yield assumed.
[7] Based on 8.3 years life for combine, 10 years for binder, 15 years for header.
[8] Annual charge per machine based on one-half the first cost at 6 per cent.

With an assumed yield of 15 bushels per acre, this would be equivalent to an average of approximately 10 cents per bushel with the combine, 22 cents per bushel with the header, and 28 cents per bushel with the binder.

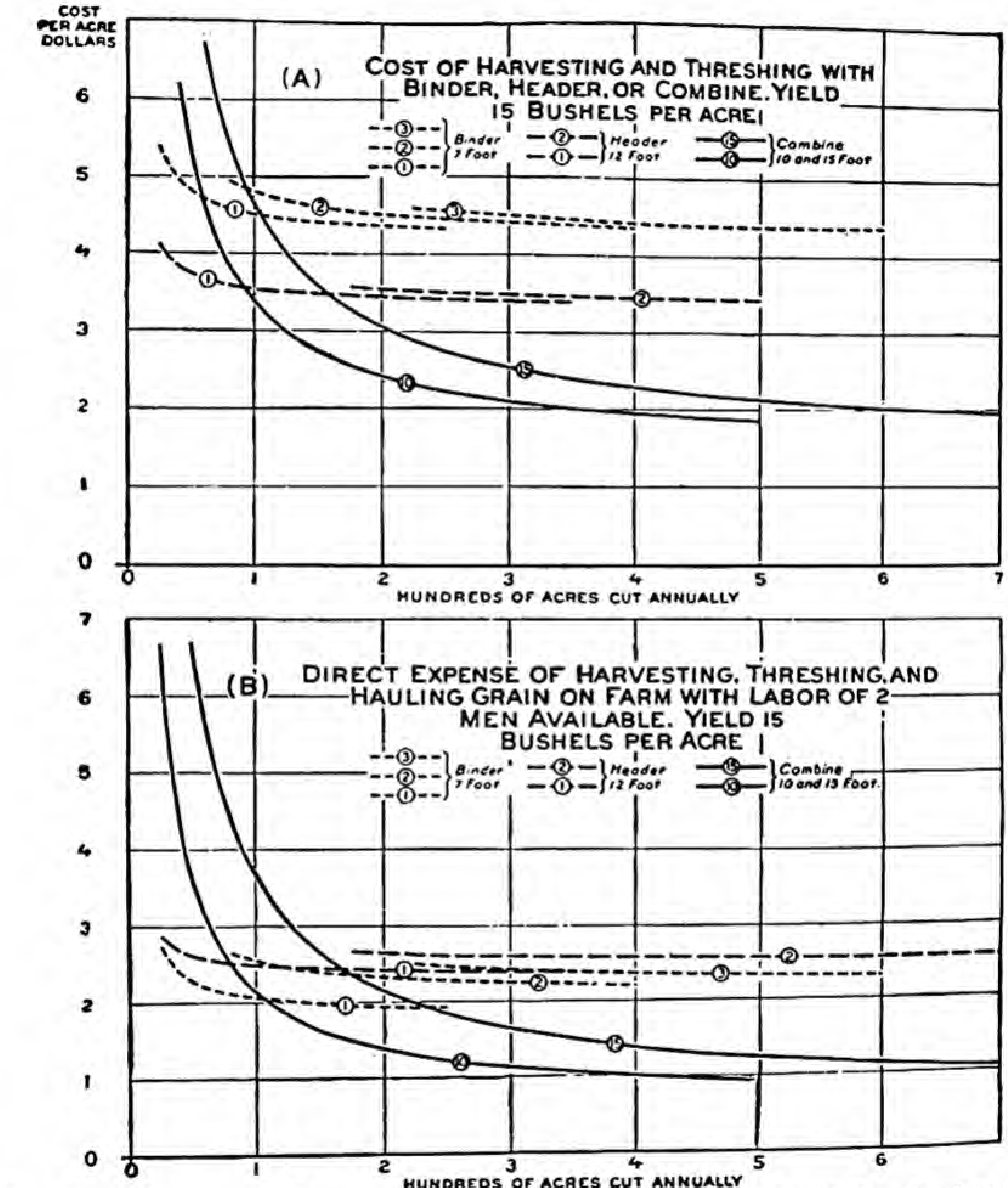


FIG. 585.—Comparative harvesting, threshing, and hauling cost with binders, headers, and combines. (*U. S. Dept. Agr. Tech. Bull.* 70, *p.* 31, 1928.)

If depreciation, interest on investment, and insurance were added, the cost per bushel for the different methods would be, approximately, 14, 23, and 29 cents, respectively if over 200 acres are cut annually.

The graph shown in Fig. 585 gives a comparison of the harvesting costs for combines, headers, and binders. Figure 585*A* is based on

Table XVII. Figure 585*B* shows the estimate of immediate costs for different machines with no allowance made for unpaid labor, power, or interest on the investment.

McGee and McCune[1] found that when rice was harvested by binding, shocking, and threshing, the labor and power requirements per acre were as follows: 13.3 man-hours, 7.1 horse-hours, 0.95 tractor-hours, and 0.40 truck-hours.

When rice is combined it must be dried It was found that in harvesting and drying rice, using 14-foot self-propelled combines and handling the rice in bulk, the labor and power requirements per acre were as follows: 2.65 man-hours, 0.56 tractor-hours, 0.88 truck-hours, and 0.56 combine-hours.

TABLE XVIII.—ACRES CUT PER HOUR AND PER FOOT OF WIDTH BY COMBINES OF DIFFERENT TYPES AND SIZES[1]

Type of combine	Width of cut, feet	Combines, number	Yield per acre, bushels	Rate of travel, miles per hour	Length of day, hours	Cut per day, acres	Cut per hour, acres	Cut per hour per foot of width, acres
Tractor drawn with power take off	8	25	17	2.4	10.3	16	1.6	0.19
	10	10	24	2.7	9.8	26	2.6	0.26
Tractor drawn with auxiliary engine	12	56	17	2.8	10.2	27	2.6	0.22
	15	51	18	2.8	10.3	35	3.4	0.23
	16	104	21	2.8	10.7	40	3.7	0.24
	20	3	25	2.4	10.7	48	4.5	0.22
All tractor drawn	....	249	19	2.8	10.4	33	3.2	
Horse drawn	12	3	11	2.5	10.0	23	2.3	0.19
	15	3	13	2.7	10.2	30	2.9	0.19
	16	2	14	2.5	11.5	38	3.3	0.21
All horse drawn	....	8	12	2.5	10.3	29	2.8	

[1] *U. S. Dept. Agr. Tech. Bull.* 70, p. 40, 1928.

488. Acres Cut by Combines.—Most people think of the capacity of a machine as the amount of work it can do in a day's time. The principal factors that influence the rate of cutting are the size of the machine, rate of travel, and yield of grain.

Reynoldson, Kifer, Martin, and Humphries[2] calculated, from 214 reports of combines equipped with auxiliary engines, that the rate of

[1] *Tex. Agr. Expt. Sta. Prog. Report* 880, 1943.

[2] *U. S. Dept. Agr. Tech. Bull.* 70, p. 14, 1928.

cutting would be increased 0.27 acre per hour by the addition of each foot to the length of the cutter bar. The average cut per hour for each foot of width was approximately 0.23 acre. The rate of cutting depends upon the rate of travel and upon the size of the machine.

They also stated that

> . . . on this basis a 10-foot machine in 20-bushel wheat, traveling 2.5 m.p.h., should cut 20.5 acres in a 10-hour working day. A 12-foot machine should cut 25.9 acres, a 15-foot machine 34 acres, a 16-foot machine 36.7 acres, and a 20-foot machine 47.5 acres.
>
> A 10-foot combine should harvest 375 acres in a 15-day harvest season. The minimum profitable acreage in the Great Plains for a machine of this size is about 150 acres; the maximum is about 640 acres. A 15-foot combine should harvest 525 acres in 15 days, with a minimum of 200 and a maximum of 1,100 acres.

Table XVIII shows the average rate of travel, the length of day, the acres cut per hour and per foot of width by combines of different types and sizes.

Self-propelled combines with a 14-foot cutter bar can harvest small grain and sorghum at the rate of 40 to 50 acres per day. In harvesting rice in soft fields and where contour ridges must be crossed, 27 acres were harvested per day with a 14-foot self-propelled combine.

489. Harvesting Losses.—The figures given by Reynoldson, Kifer, Martin, and Humphries show that the average harvesting loss with combines is 2.6 per cent of the total yield, as compared with 3.3 per cent for a header and 6.1 per cent for a binder. The actual loss of grain when harvested with the combine averaged 32 pounds per acre, as compared with 40 pounds with the header and 74 pounds with the binder.

CHAPTER XXVI

CORN SHELLERS AND HUSKER-SHREDDERS

CORN SHELLERS

After the corn has been harvested it is necessary to prepare it for market by separating the kernels from the cob. There are two types of corn shellers, spring and cylinder.

490. Spring Shellers.—Spring shellers are of various sizes according to the number of holes provided for shelling. The sizes are one-, two-,

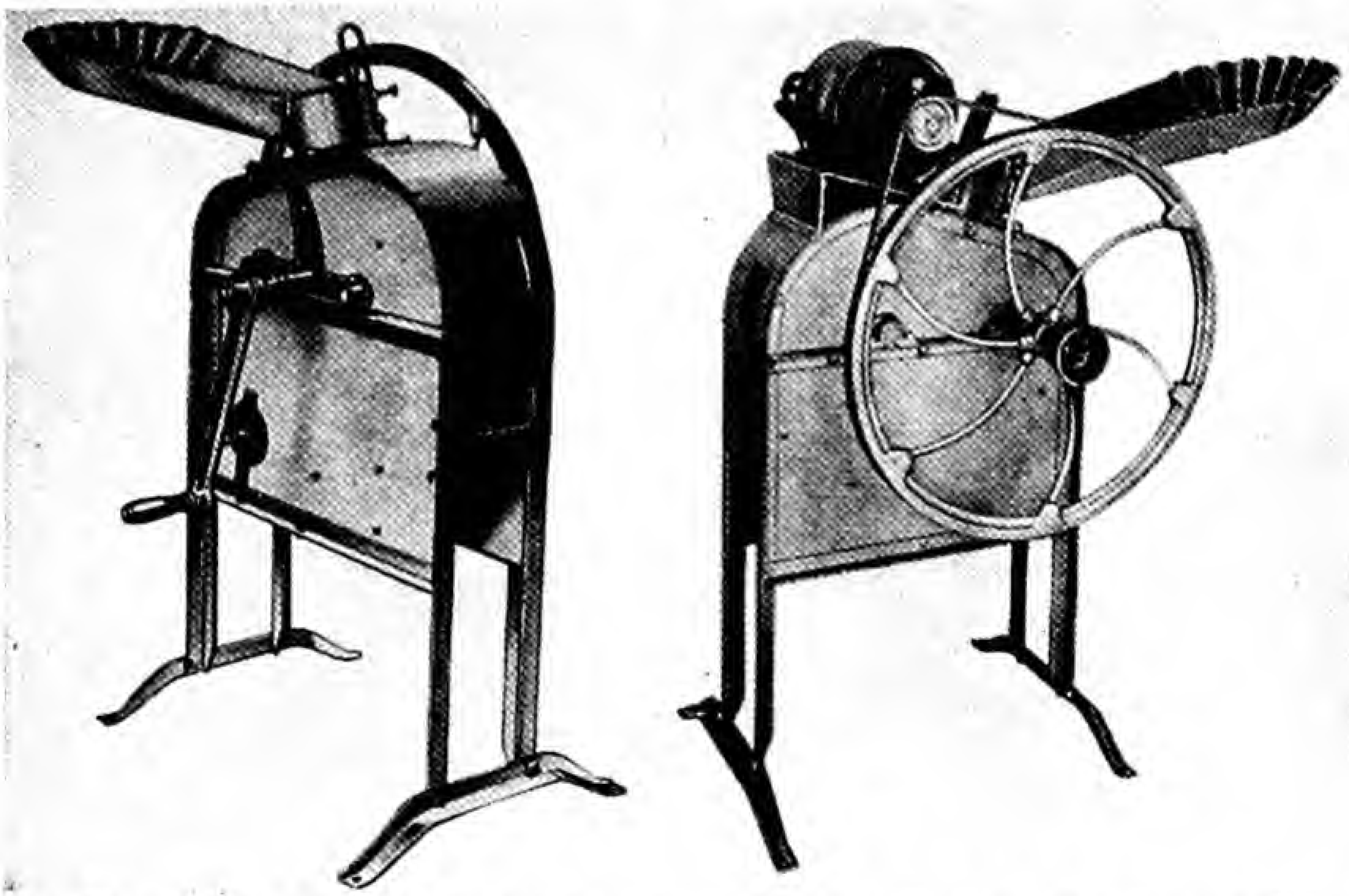


Fig. 586.—One-hole spring corn sheller can be operated either by hand, by electric motor, or by gasoline engine.

four-, and six-hole. The one- and two-hole sizes are small hand or power shellers (Fig. 586), while the four-hole and six-hole sizes are larger power shellers. Figure 587 shows the various parts of a one-hole sheller, while Fig. 588 shows a two-hole sheller.

Referring to Fig. 588, the shelling operation is as follows: The corn is delivered to the feeder A. The ears fall on the feeder chain B and are carried into the picker wheels C. The beater D aids in feeding and prevents the ears from bridging. The kernels are shelled from the cob as the

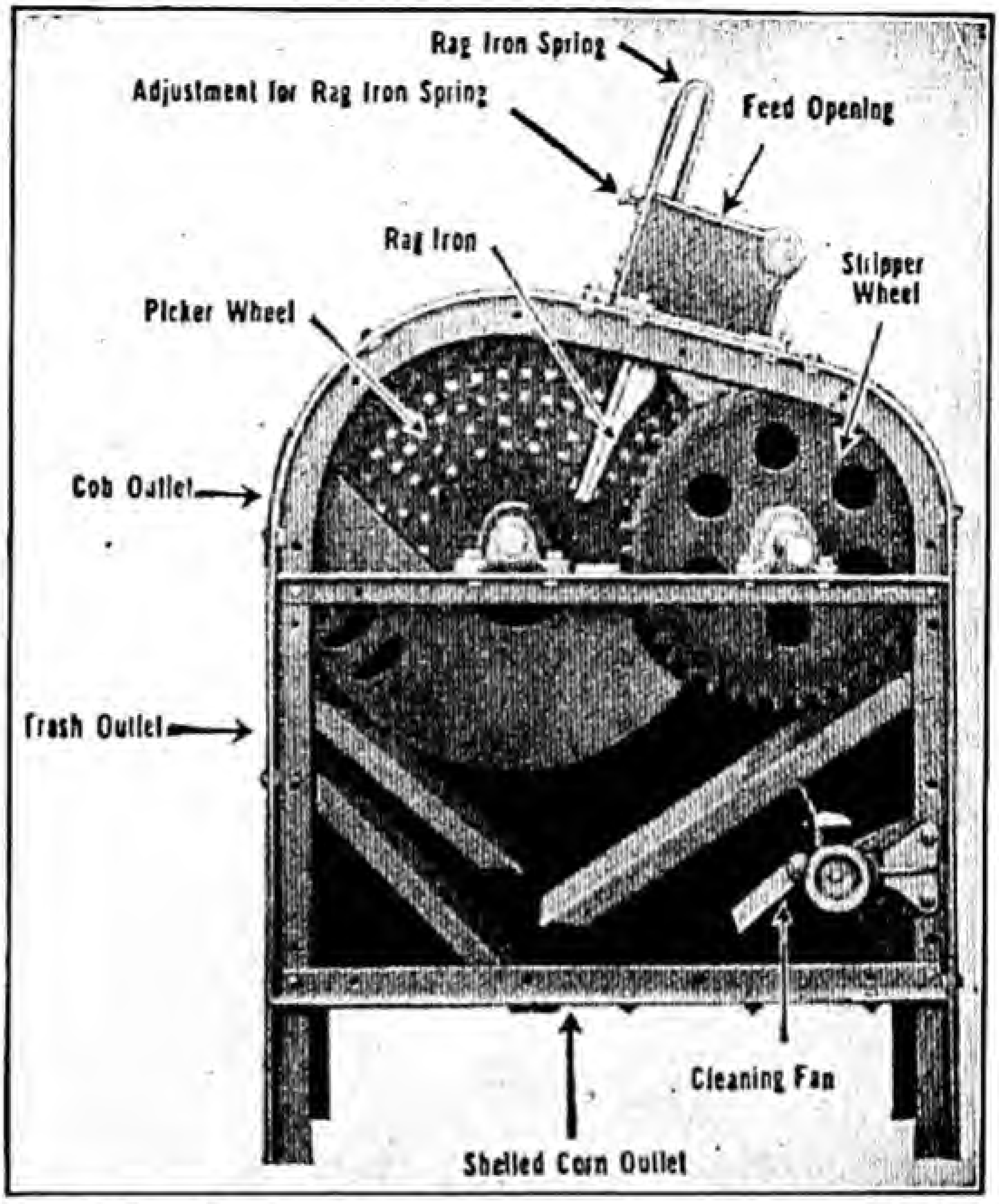


FIG. 587.—Sectional view of one-hole spring corn sheller.

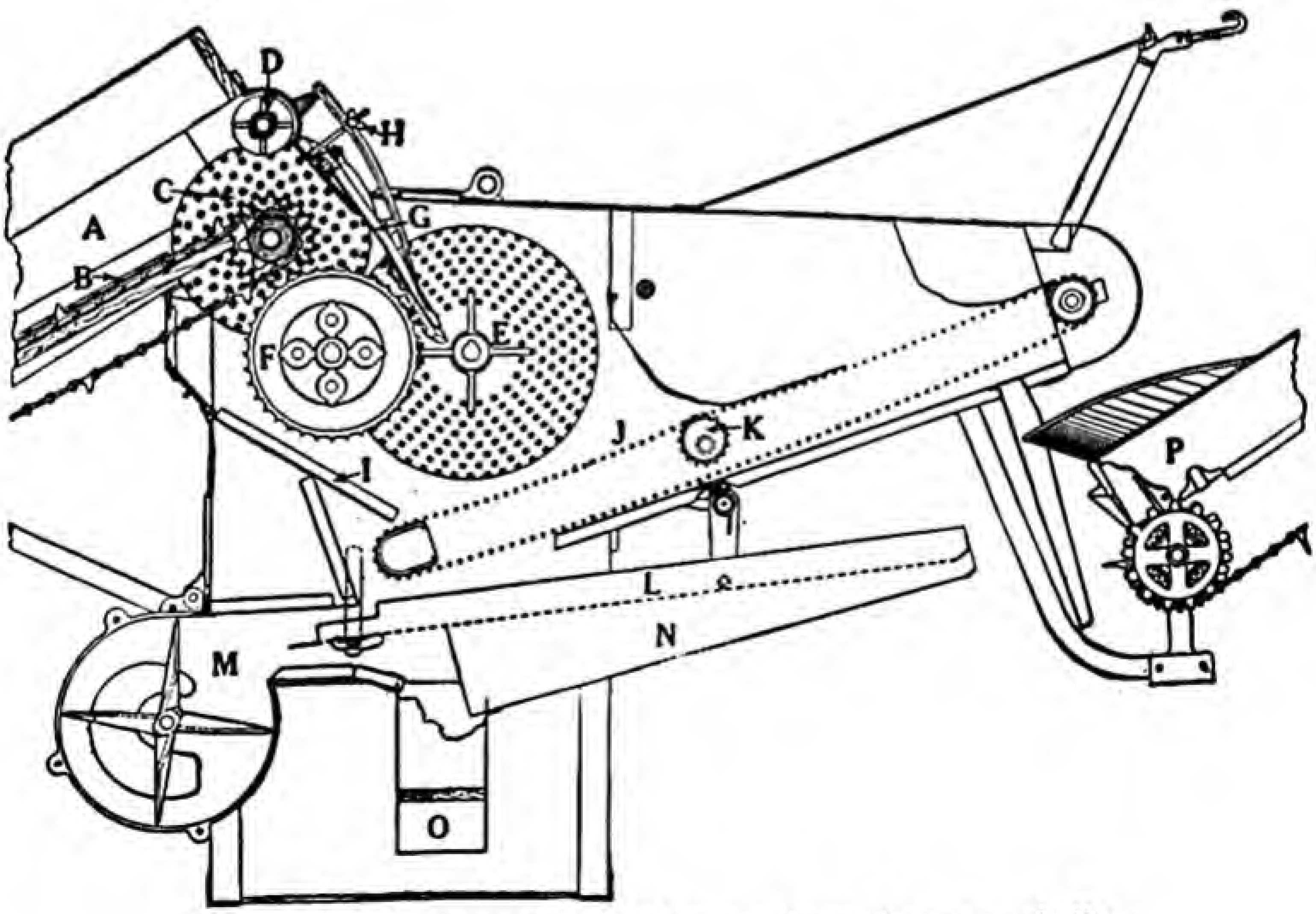


FIG. 588.—Sectional view of two-hole spring corn sheller.

ears pass between the runners E and F and the rag iron G. The tension on the rag iron can be adjusted by the thumb nut H so that small or large ears can be shelled.

The shelled corn drops through the shelling wheels onto incline I. The cobs, husks, and silks drop onto a wire cob rake J which is agitated by the eccentric sprocket K. The shelled corn that passes on with the cobs and that from incline I fall through the wire cob carrier J onto the cleaning sieve L. As the corn falls from the sieve L to the pan below, it is subjected to a blast of air which separates the chaff, silks, and small cob ends from the shelled corn. The grit and sand are removed as the shelled corn gravitates down over the sand screen N. The clean corn is delivered to the boot O and carried outside the machine. The cobs, silks, and other foreign material pass over the cob rake into the swinging cob stacker P.

491. Cylinder Shellers.—The trend in cylinder corn shellers is away from the large, power-consuming shellers to the smaller shellers requiring

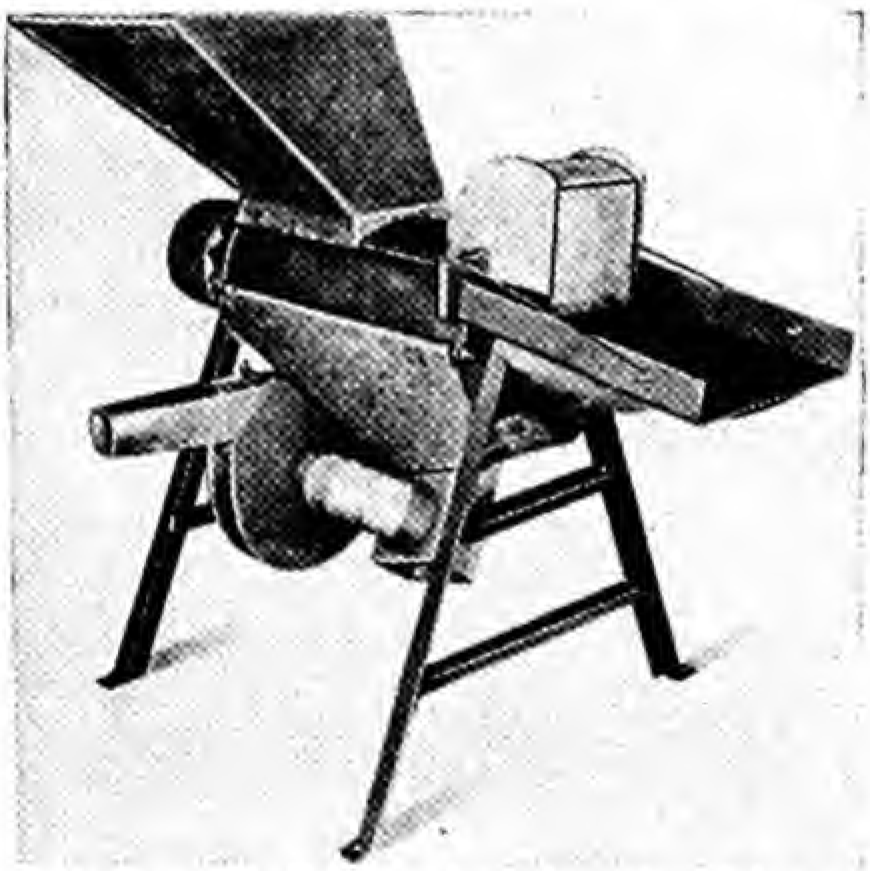


FIG. 589.—Small cylinder corn sheller requiring less than 5 horsepower for operation.

less power for operation yet having sufficient capacity for general farm use. A grain dealer who buys ear corn and processes it for shipment in bags or bulk, will, of course, need a large-capacity machine. Figure 589 shows a small cylinder sheller requiring less than 5 horsepower to operate with an alleged capacity up to 120 bushels per hour.

The cylinder sheller shown in Fig. 590 is a popular type for the farm. It is simple and requires little adjustment. The ears of corn enter the "cage" (Fig. 591) in which a steel cylinder (Fig. 592), spirally studded with lugs and revolving at an approximate speed of 700 r.p.m., rubs the kernels off the cobs (Fig. 591). Perforations in the bottom of the cage

permit the shelled corn to fall through to the enclosure below. The cobs are moved along by the cylinder through the cage automatically to the cob outlet. As the shelled corn falls from the cage, it passes through an

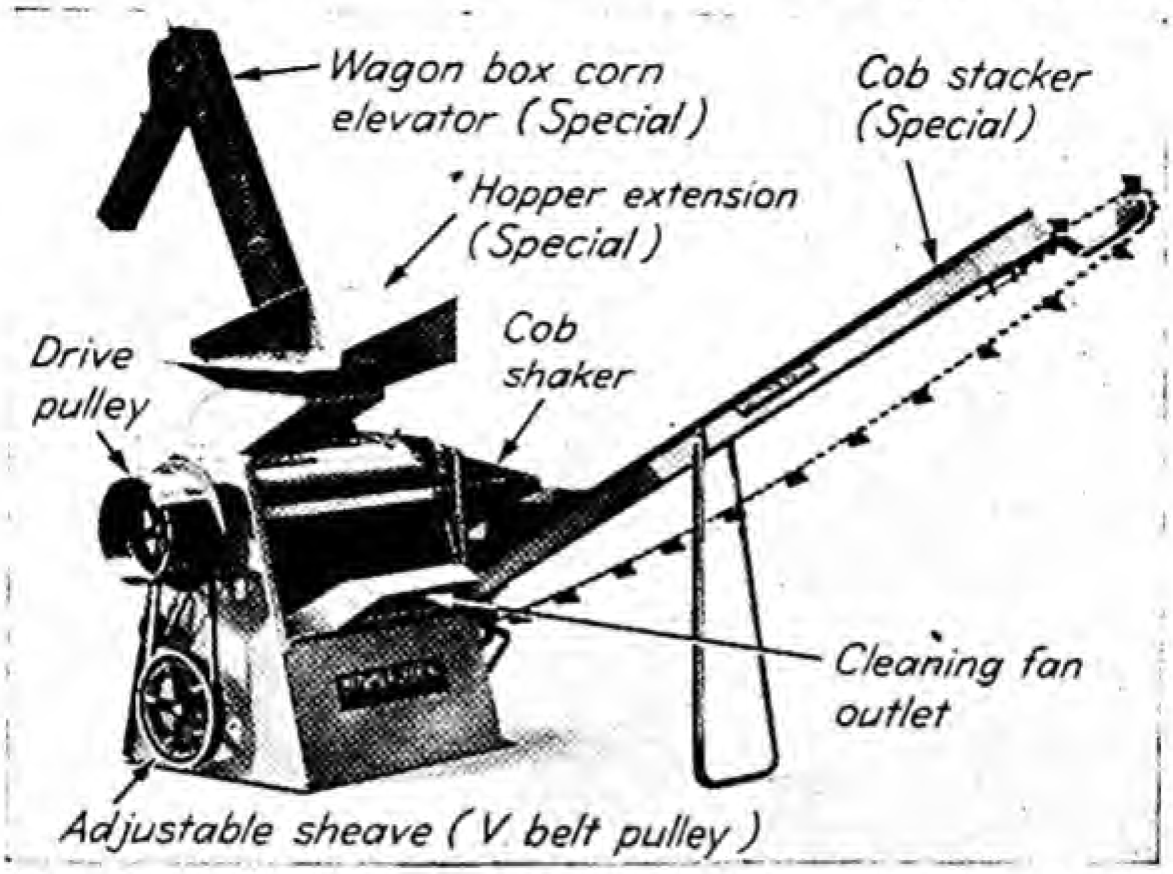


FIG. 590.—Cylinder corn sheller for shelling of husked corn.

air blast which blows out the chaff and trash. The size of the cob outlet can be adjusted to retard the flow of ears and cobs if shelling is difficult.

This type of cylinder sheller is designed more especially for husked corn. However, it will shell ears with husks but much more slowly. A large percentage of the corn crop is now being harvested with corn pickers

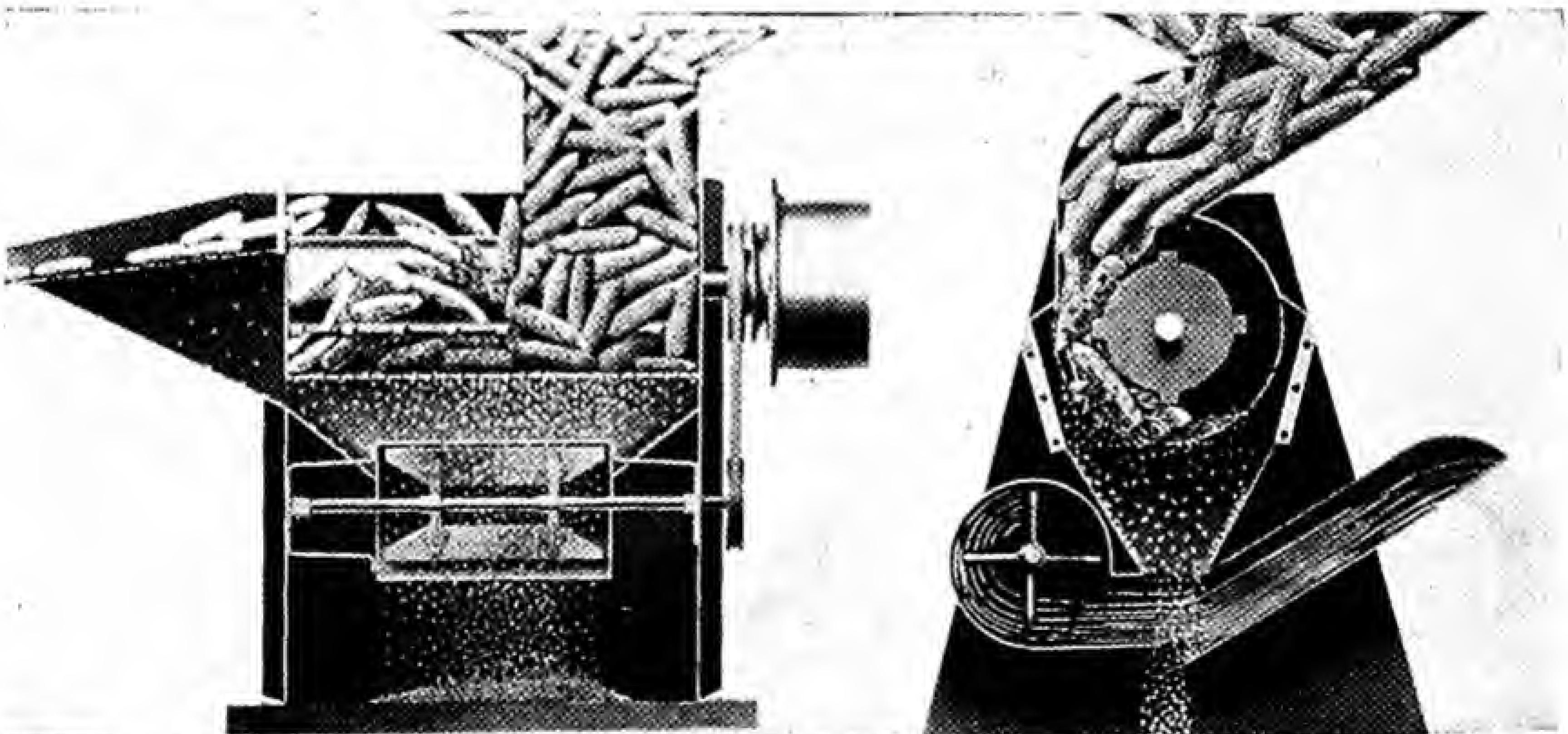


FIG. 591.—Side and end views of cylinder corn sheller shown in Fig. 590. Note separation of corn from cobs and air blast for cleaning corn.

equipped with husking attachments and when such is the case only husked ears are shelled.

It was stated in the discussion of corn pickers that there are sheller attachments for corn pickers; such a machine is called a *picker-sheller*.

Some corn shellers are designed to handle snapped corn with the husk on the ears. Such a machine is shown in Fig. 593.

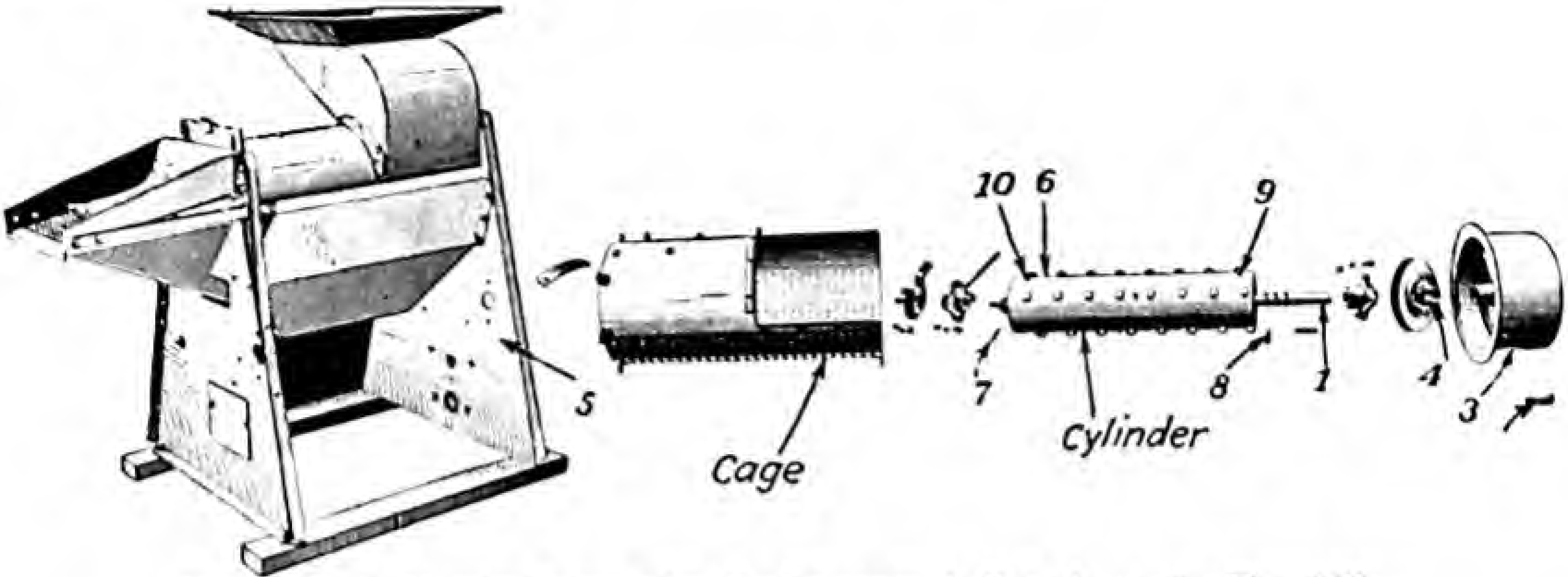


FIG. 592.—Exploded view of cylinder corn sheller shown in Fig. 590.

492. Attachments for Shellers.—There are several attachments for corn shellers which facilitate the handling of the shelled corn and the refuse. They include a *cob stacker* (Fig. 590), *elevators* for either truck or bag, and a *corn thrower*.

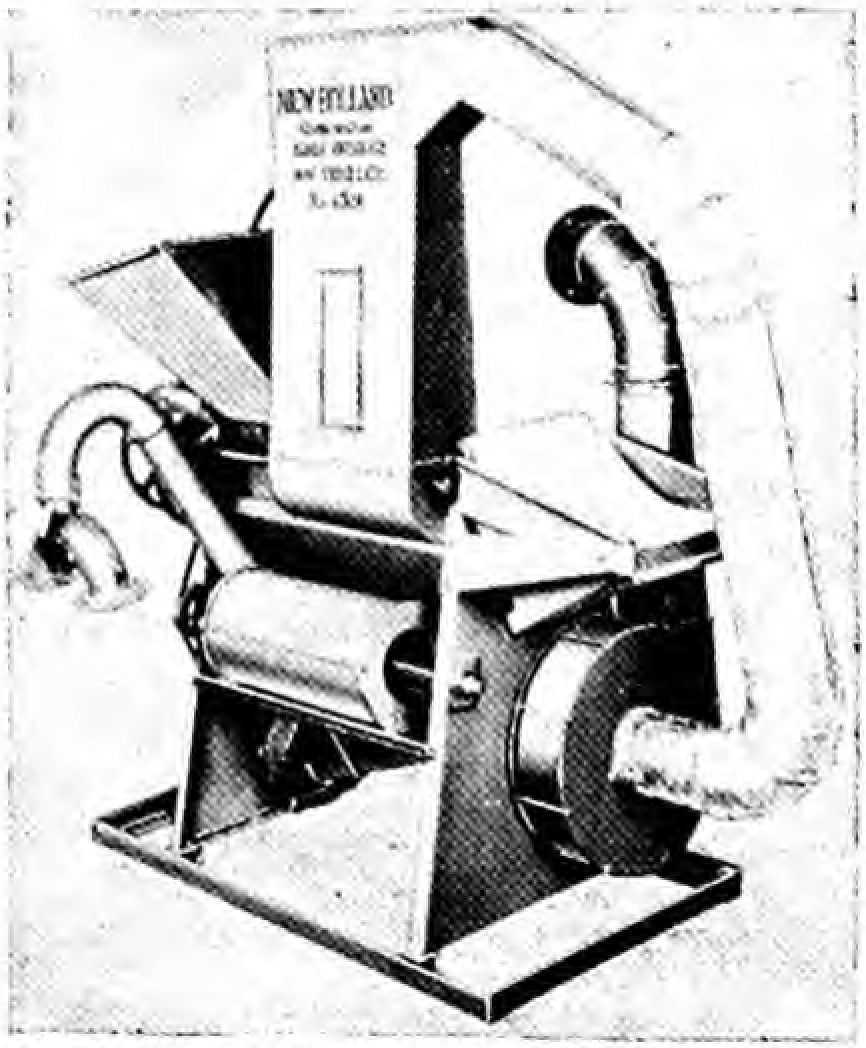


FIG. 593.—Husker-sheller equipped with bagger and blower.

493. Capacity and Power.—The small sheller shown in Fig. 589 is equipped with a 3-horsepower motor and will shell up to 120 bushels of husked corn per hour. The machine shown in Fig. 590, with a capacity up to 150 bushels of husked corn per hour, requires a 5- to 10-horsepower motor. Large shellers may have a capacity up to 700 bushels per hour

and require 25 to 40 horsepower. Extra-large machines, which will shell up to 1,400 bushels per hour, require up to 50 horsepower.

HUSKER-SHREDDERS

The husker-shredder is a machine which removes the ears from the stalks; then, it removes the husks from the ears and also shreds the stalks,

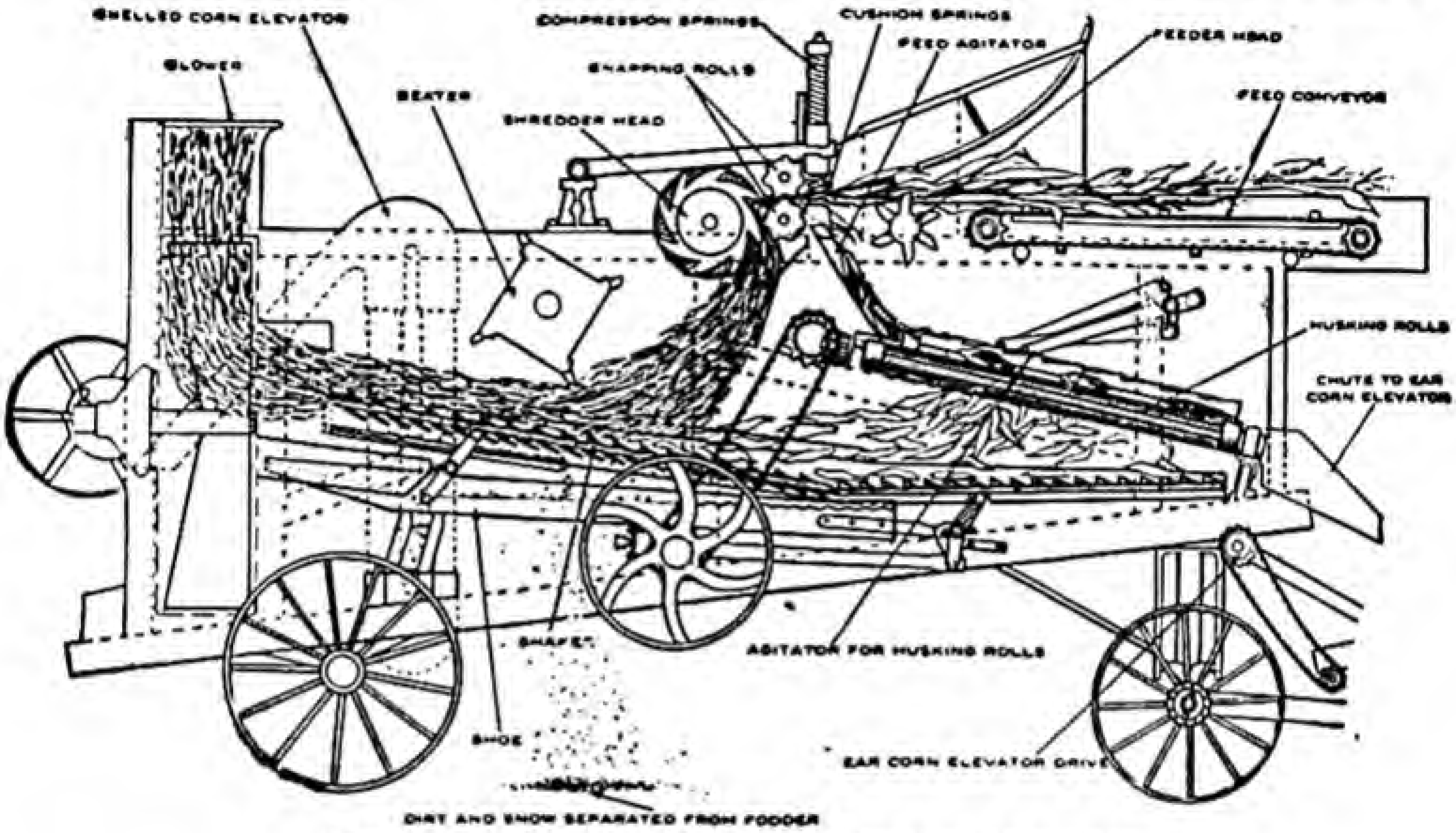


FIG. 594.—Sectional view of husker-shredder.

blowing them with the husks into the barn (Fig. 594). The machine handles corn that has been cut and shocked. The husker-shredder husks quickly and makes practically all the *stover* available for feed.

494. Size.—The size of a husker-shredder is designated by the number of husking rolls with which the machine is equipped; it is known as a two-, four-, six-, eight-, or ten-roll machine.

495. Operation.—A cross-sectional view of a husker-shredder is shown in Fig. 594. The stalks with the ears on them are thrown on the feed

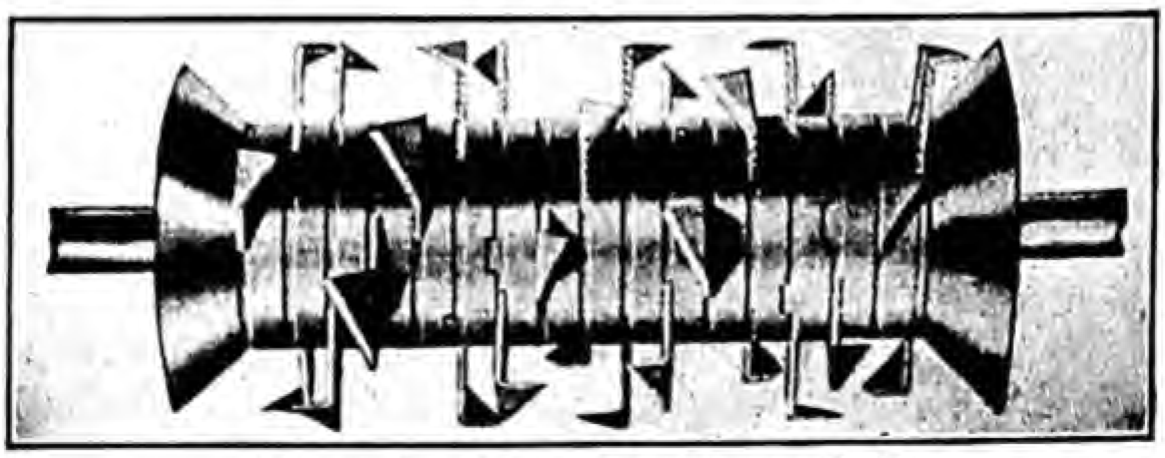


FIG. 595.—Knife-shredder cylinder.

conveyor, and the feeder head feeds them into the snapping rolls where the ears are removed from the stalks. The ears drop down upon the husking rolls where the husks are removed, after which the ears pass out of the machine, while the husks are carried back over the shaker. Any

kernels of corn that might have been shelled by the husking rolls are removed by the shaker.

As the stalks pass through the snapping rolls, they come in contact with the shredding cylinder (Fig. 595), which thoroughly shreds the

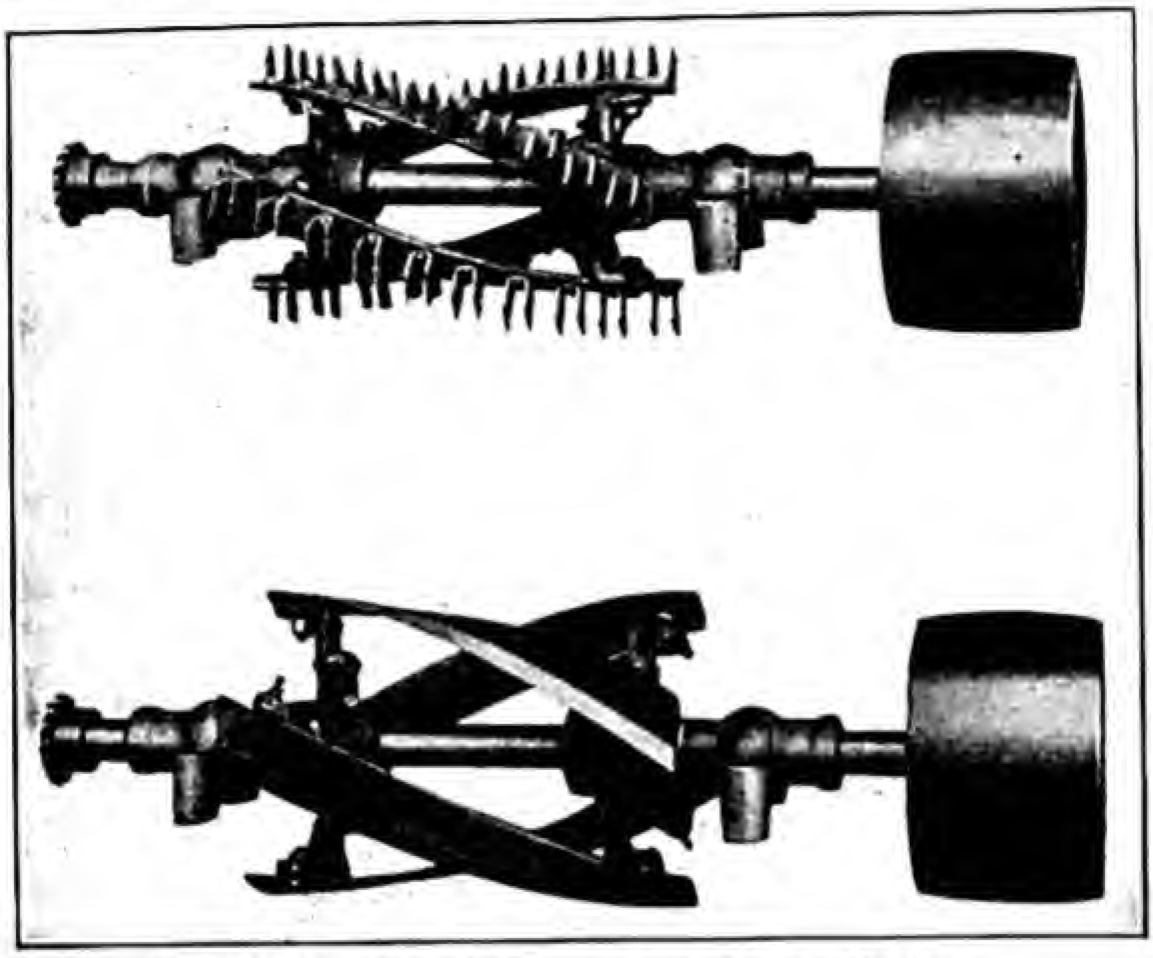


FIG. 596.—Shredding and cutting cylinders.

leaves and stalks. The shredded material or stover is carried to the blower where it is blown into the barn or other storage place. Sometimes a cutting cylinder (Fig. 596) is used instead of the shredding cylinder. The stalks are cut into short lengths like silage.

PART X

FEED-PREPARATION MACHINERY

CHAPTER XXVII

FEED GRINDERS

In the feeding of livestock, it has been found that more animal nutrition and food constituents can be assimilated and put into flesh on an animal if the feed is ground rather than left whole. Every farmer who has any livestock to feed, therefore, would find it advantageous to secure a small feed grinder to grind the feed before it is fed to the stock. Small feed grinders that can be operated by gasoline engines or small electric motors are preferable. These grinders can be divided into three types, depending upon the method of grinding, namely, the burr, hammer, and combination burr and roughage.

BURR GRINDERS

Most of the burr feed grinders (Fig. 597) are equipped with flat, roughened, chilled-iron plates which are often called *burrs;* hence, the

FIG. 597.—Typical burr-type feed grinder.

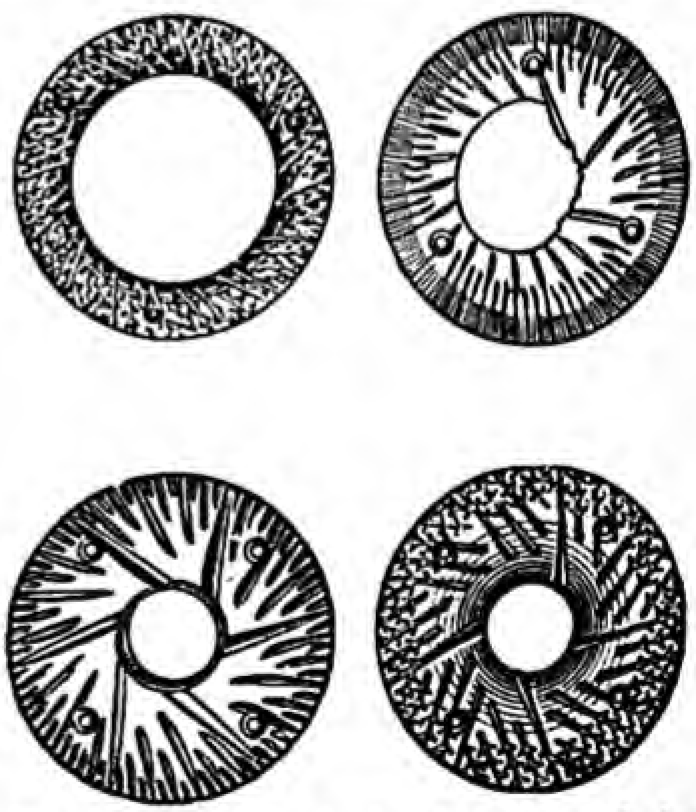


FIG. 598.—Typical plates used in burr mills.

name *burr grinders.* Burr feed-grinder mills are not generally adaptable to grinding roughages of high fiber content.

496. Types of Plates.—Figure 598 shows several plates having different grinding surfaces. Some of these are for coarse grinding, while others are for medium and fine grinding.

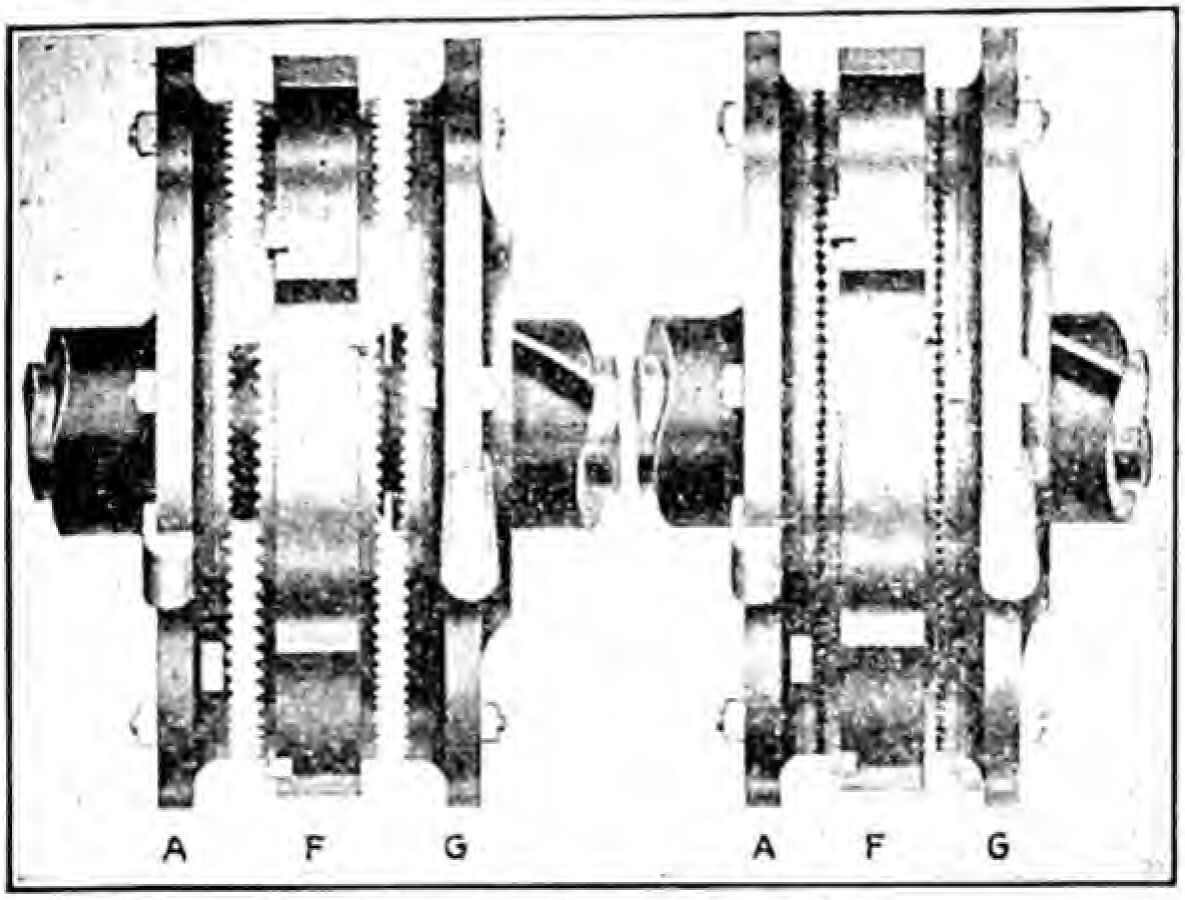


FIG. 599.—Duplex grinding plates.

Some mills use plates having one grinding surface, as shown in Fig. 598, while others use a double face or duplex plate, as shown in Fig. 599.

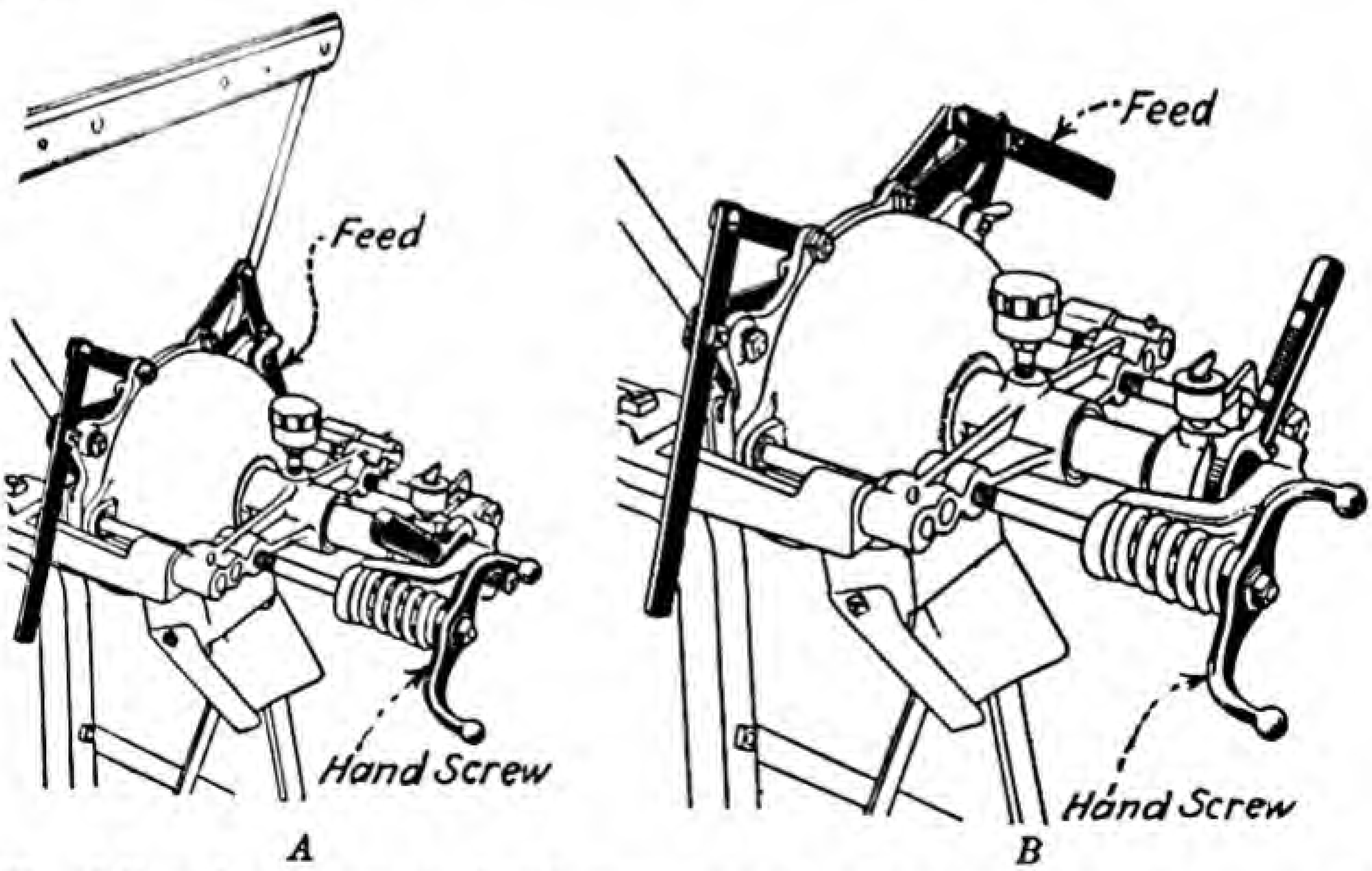


FIG. 600.—Adjust for fineness by hand screw and by closing feed gate; *A*, normal adjustment of mill when not in use; *B*, adjustment of mill when starting to grind.

Burr grinders are usually rated in sizes according to the diameter of the grinding plates, which are 6, 8, 10, and 12 inches. In operation one burr revolves and is fastened to the drive shaft; the other burr is held rigid and does not revolve.

497. Fineness of Grinding.—Several factors will influence the fineness of grinding in burr grinders. They are the rate of feeding, type of plate, speed of plates, type of material being ground, condition of plates, and tension between plates. Figure 600 shows a method of regulating the rate of feeding and also an arrangement for adjusting the tension between the plates.

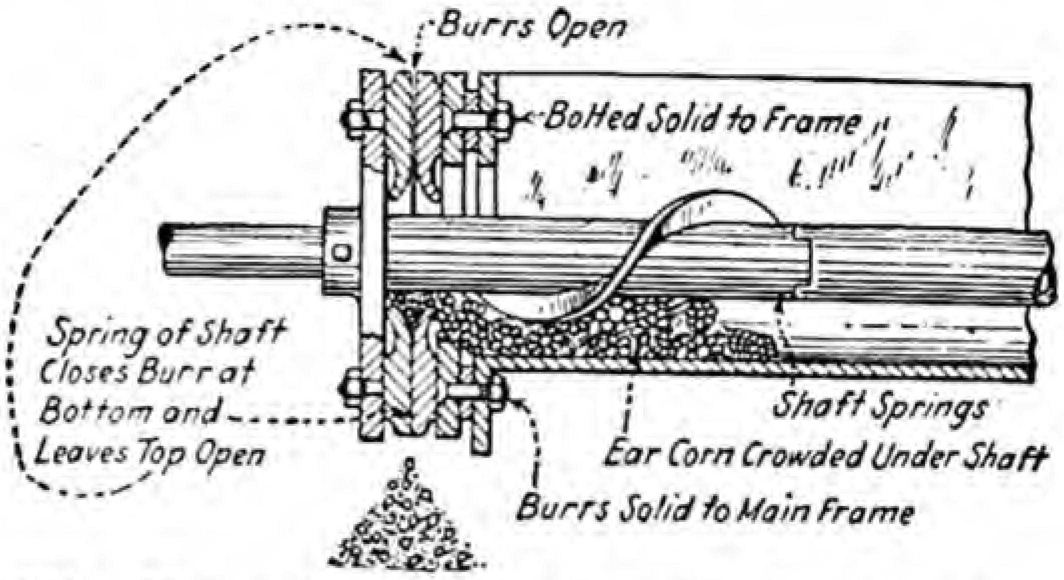


FIG. 601.—Illustrating how broken material is fed to the burrs.

The feed is fed into the center of the plate and is ground fine as it passes between the plates from the center to the outside edge, as shown in Fig. 601.

498. Breaking and Cutting Rolls.—Before the feed that is being ground reaches the grinding plates, it is broken or cut into small pieces. Figure 602 shows a grinding mechanism suitable for breaking up and

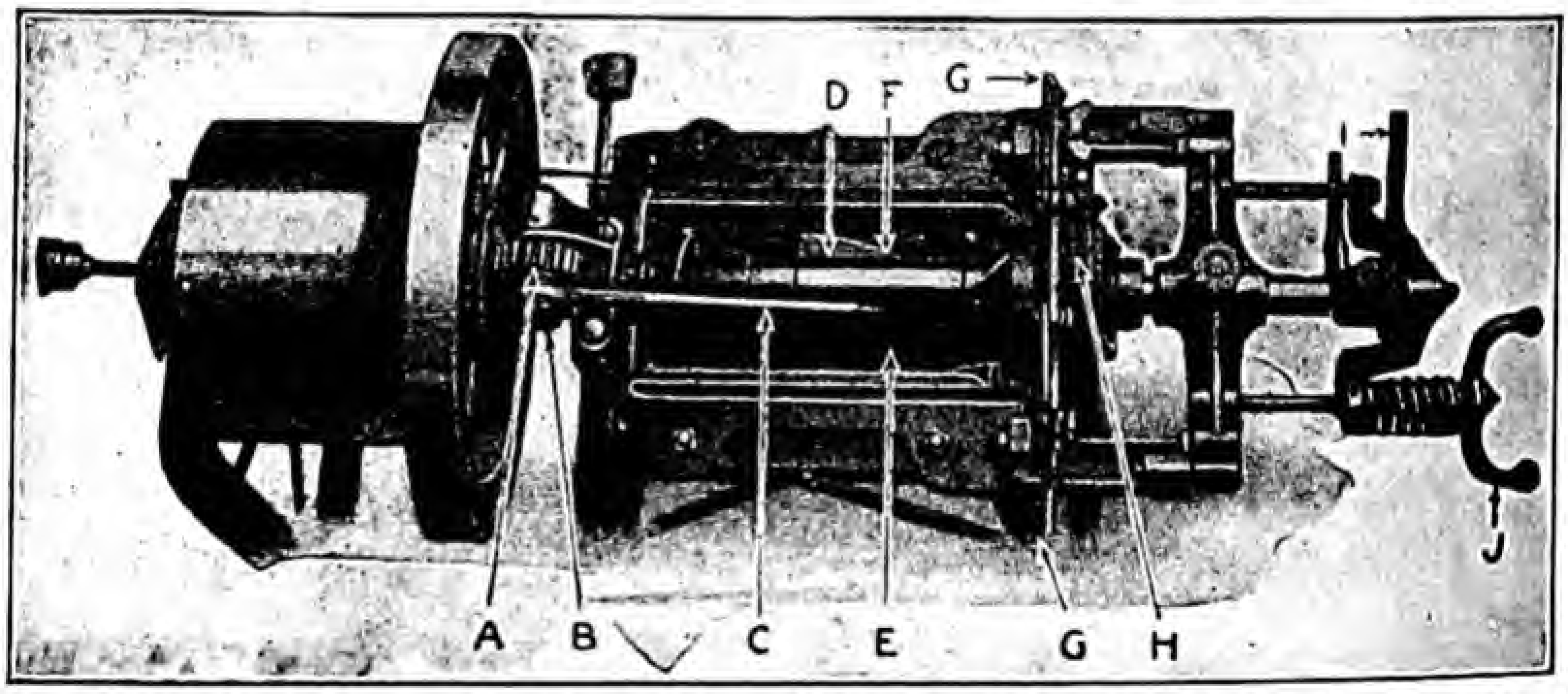


FIG. 602.—Grinding mechanism of Type B feed grinder: *A*, agitator driving worm; *B*, agitator driving gear; *C*, agitator; *D*, cob breaker; *E*, concave; *F*, cob-cutting knife; *G*, regulating slides; *H*, grinding plates; *I*, release lever; *J*, plate-adjusting crank.

grinding ear corn from which the husk has been removed. The breaker roll breaks the ears, crushes the cobs against the concaves, and feeds the mixture into the grinding plates.

The grinding mechanism shown in Fig. 603 is designed to grind corn in the husk and is provided with spiral knife rolls which cut against the cutter bar in the center, cutting the cobs and husks into small pieces.

This mill will also grind shelled corn, small grains, and grain sorghums without additional equipment.

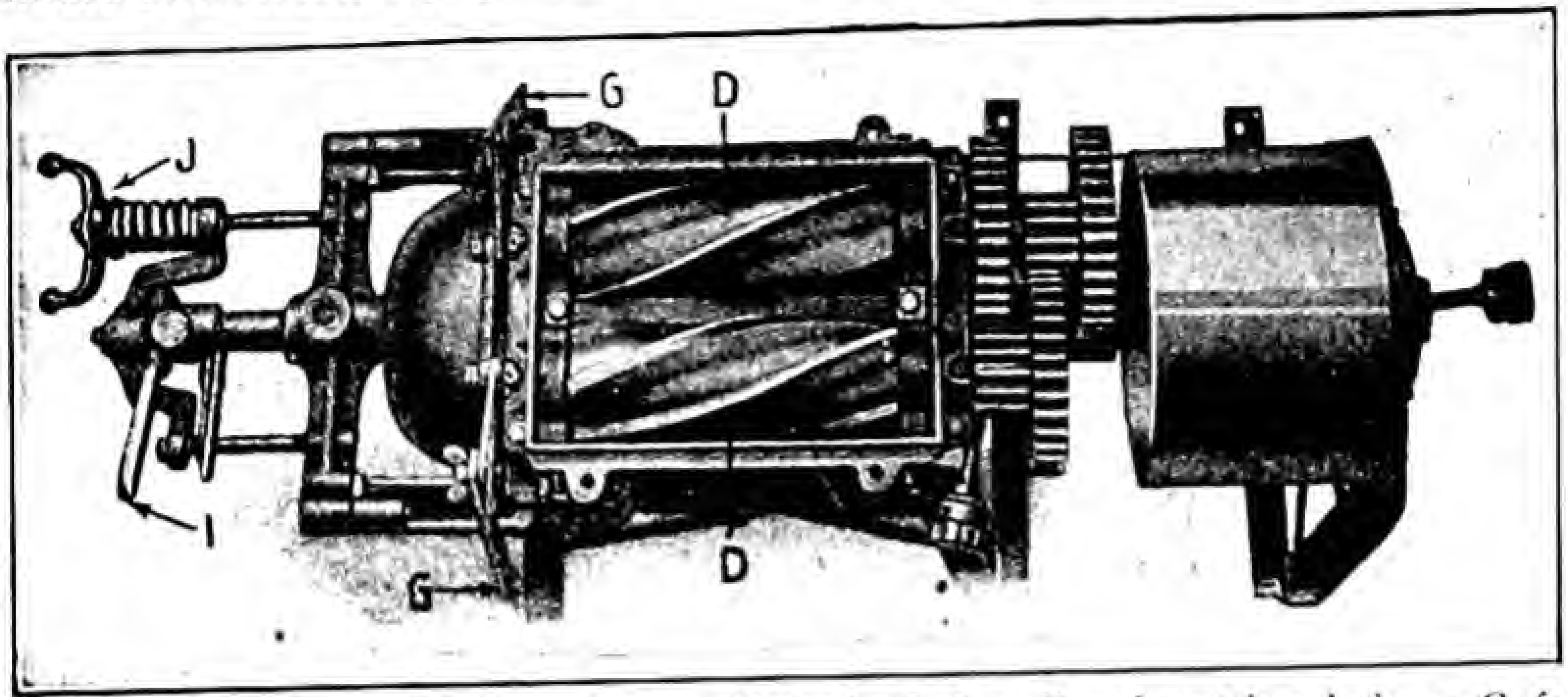


FIG. 603.—Grinding mechanism of Type-D feed grinder: *D*, cob-cutting knives; *G*, feed-regulating slides; *I*, plate-release lever; *J*, plate-adjusting crank.

499. Safety Devices.—Often, when grinding feed, foreign material is present in the form of sticks, bolts, nuts, and stones, which would be apt to injure some part of the mill. An automatic safety release should be provided to permit the burrs to separate. The concaves are usually provided with wood break pins. Some machines have a driving gear held by a wood break pin. The compression spring holding the plates together will give and allow the obstruction to pass through if it is rather small.

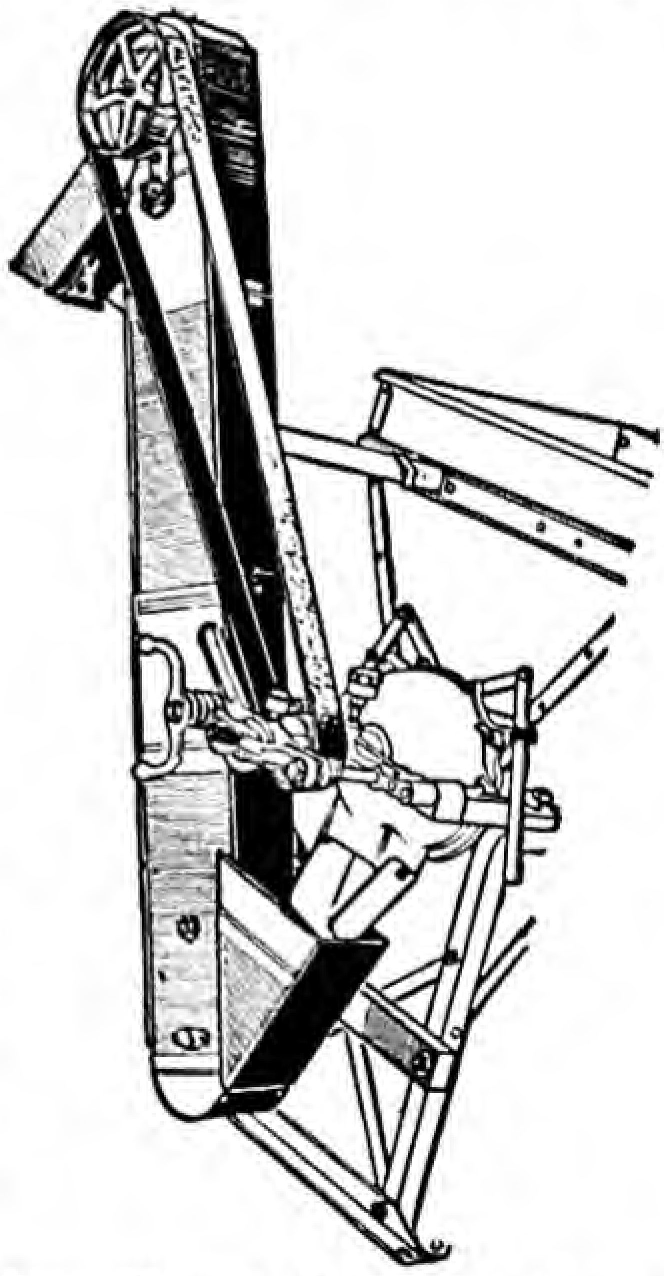
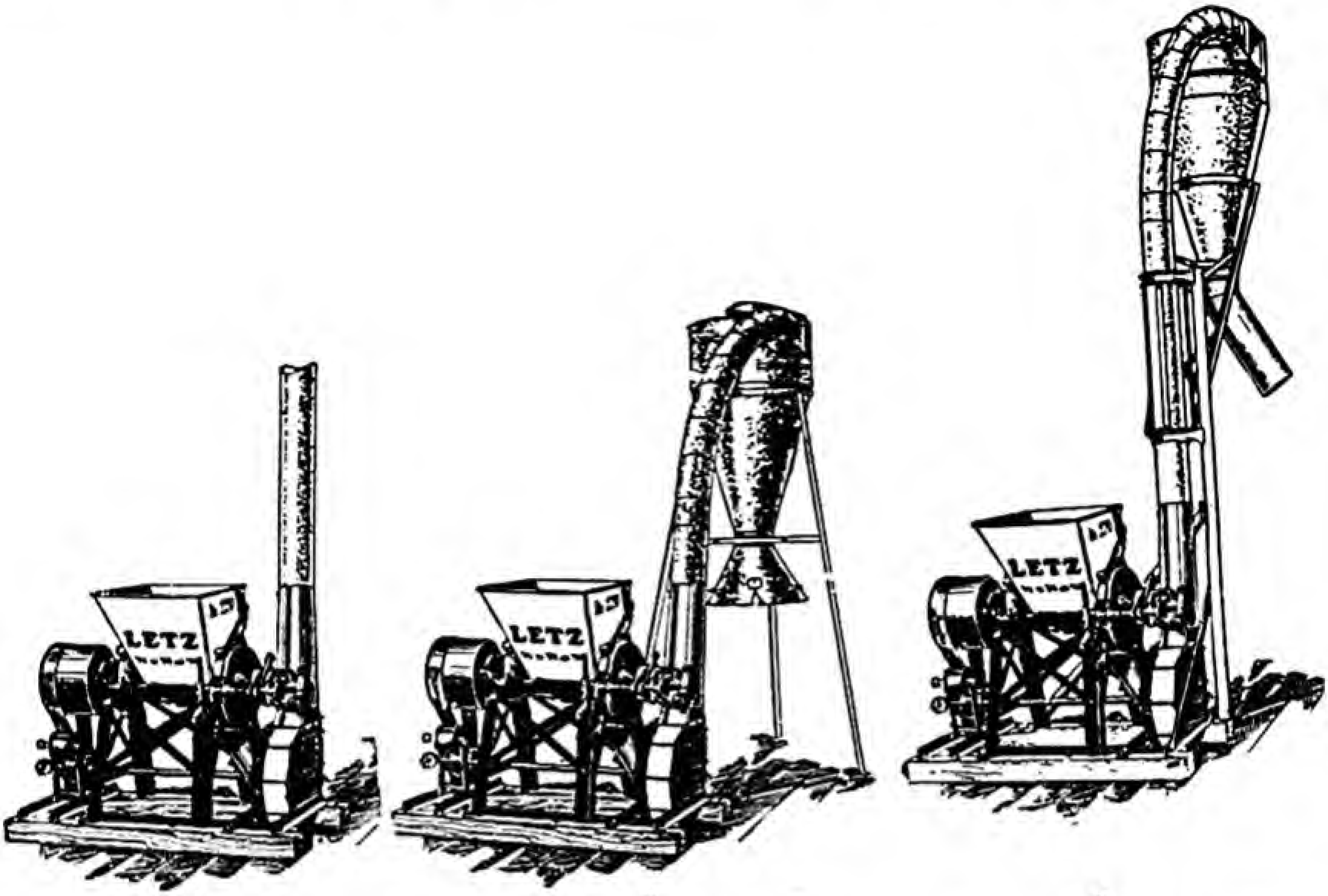


FIG. 604.—Sacking elevator attached to grinder.

500. Capacity and Power.—The capacity of burr grinders depends directly upon the diameter of the plates, the kind of material being ground, the fineness of grinding, and the speed. Bruhn[1] states that to obtain high grinding efficiency in the small burr-type mills the speed must be high and the rate of feeding regulated to eliminate crowding of the burrs. To do this, the mill should be equipped with a feeding device. The average capacity in bushels per hour is about 2 to 3 bushels for each horsepower required.

501. Bagging Attachment.—Figure 604 shows a burr mill equipped with a short elevator and spout for bagging the ground feed. Elevators

[1] *Agr. Eng.*, Vol. 17, No. 3, p. 101, 1936.



A B C

Fig. 605.—Three methods of handling ground grain from burr mill: *A*, exhaust pipe for delivery into barn; *B*, fan with bagging attachment; *C*, fan and swinging spout for delivery into bins, trucks, or trailers.

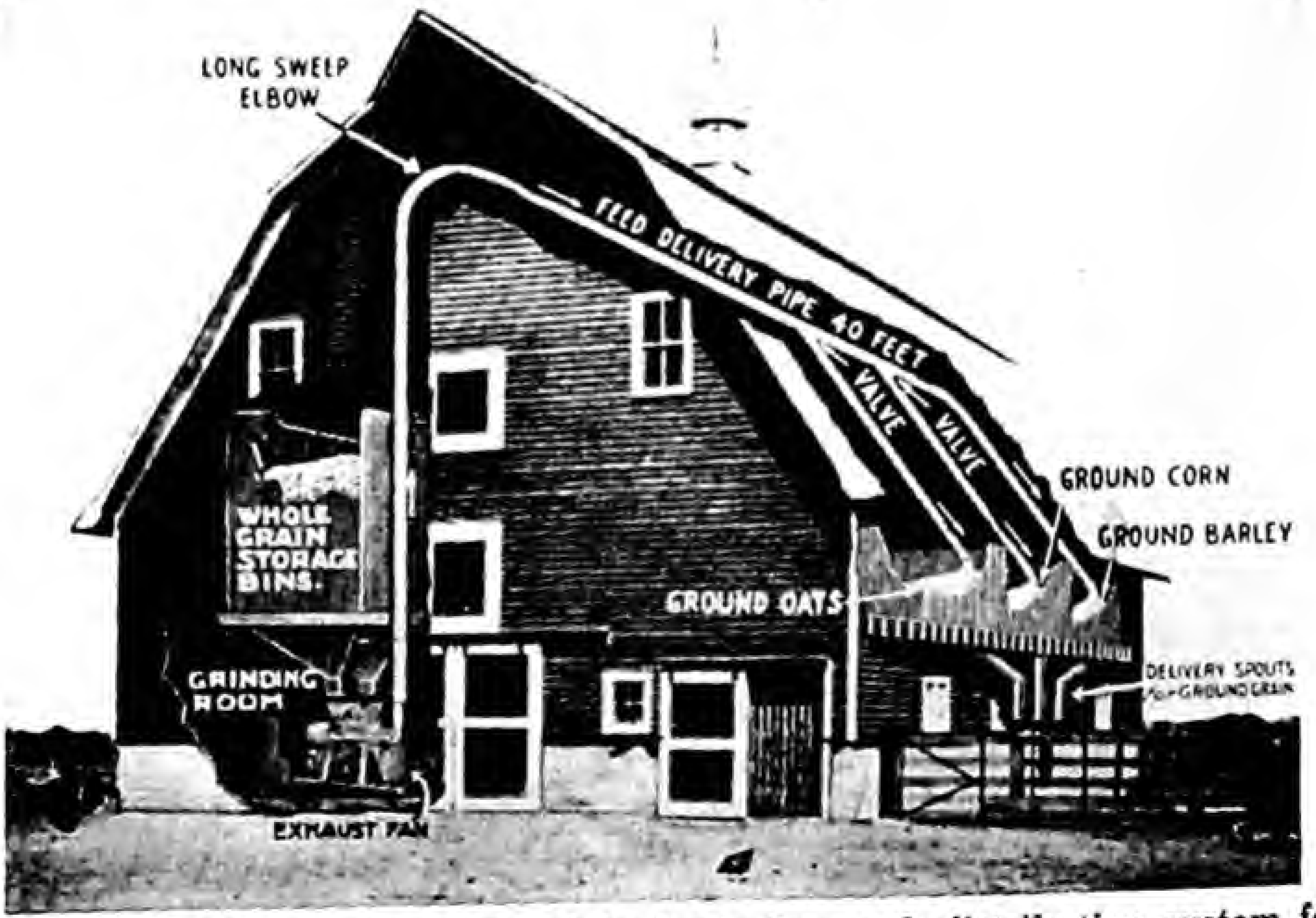


Fig. 606.—Laborsaving arrangement of feed-grinding and -distribution system for barn.

suitable for elevating the feed into a truck, trailer, or barn are also available (Figs. 605 and 606).

HAMMER MILLS

The hammer mill differs from the burr mill in that instead of flat disc plates for grinding, there are hammerlike projections mounted on a cylinder (Figs. 607 and 608). This cylinder of hammers revolves at a high rate of speed and grinds the material by beating it to pieces. It is

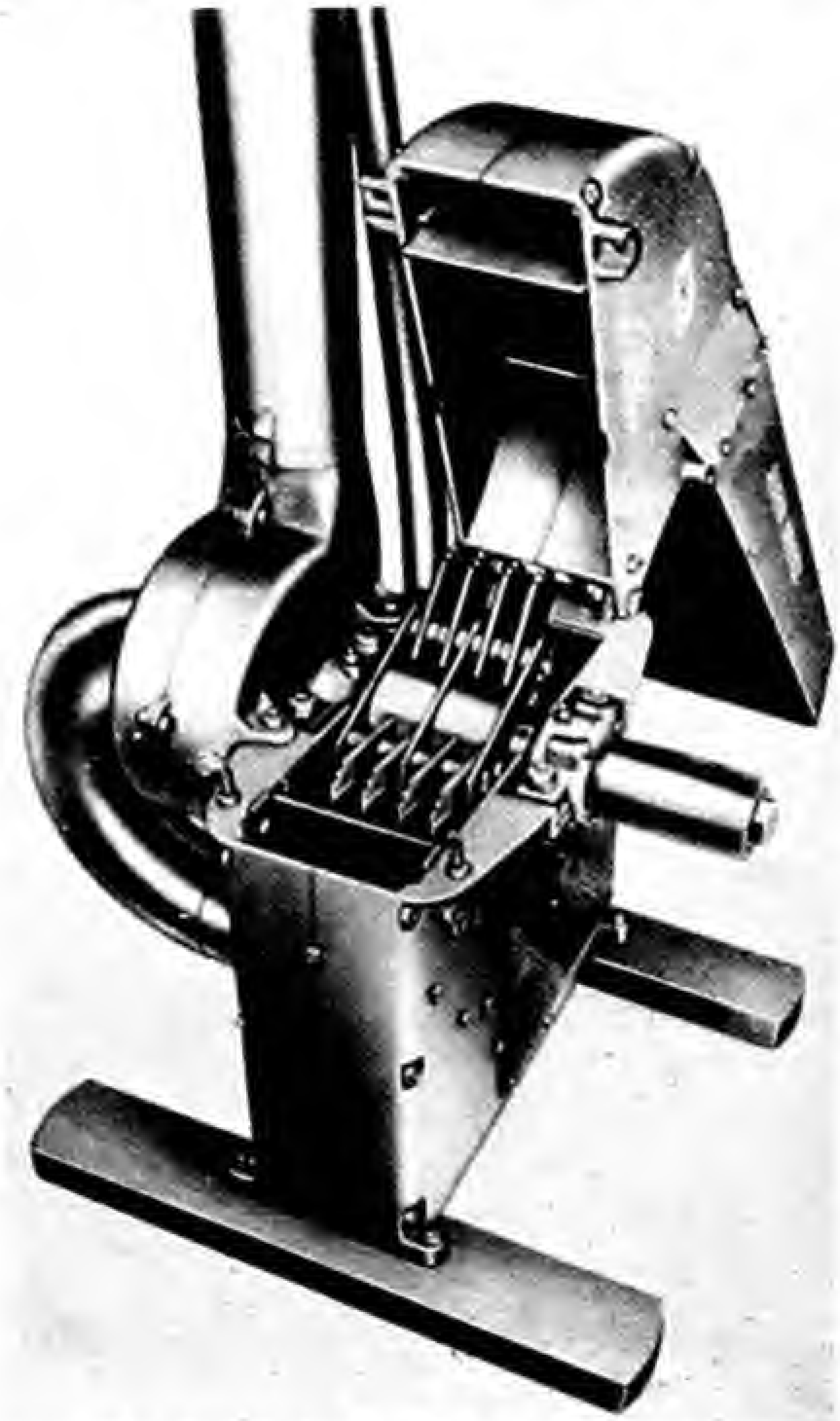


Fig. 607.—Hammer mill suitable in size for operation by the small farm tractor.

claimed that this type of mill will grind almost any material that is used for feed.

Krueger[1] gives the following advantages of a hammer mill:

1. It is not dulled by running empty.
2. Foreign material in the feed will not ordinarily injure it.
3. There is greater range in fineness.
4. Replacements are fewer.
5. Wear does not impair its efficiency.

[1] *Agr. Eng.*, Vol. 8, No. 7, p. 167, 1927.

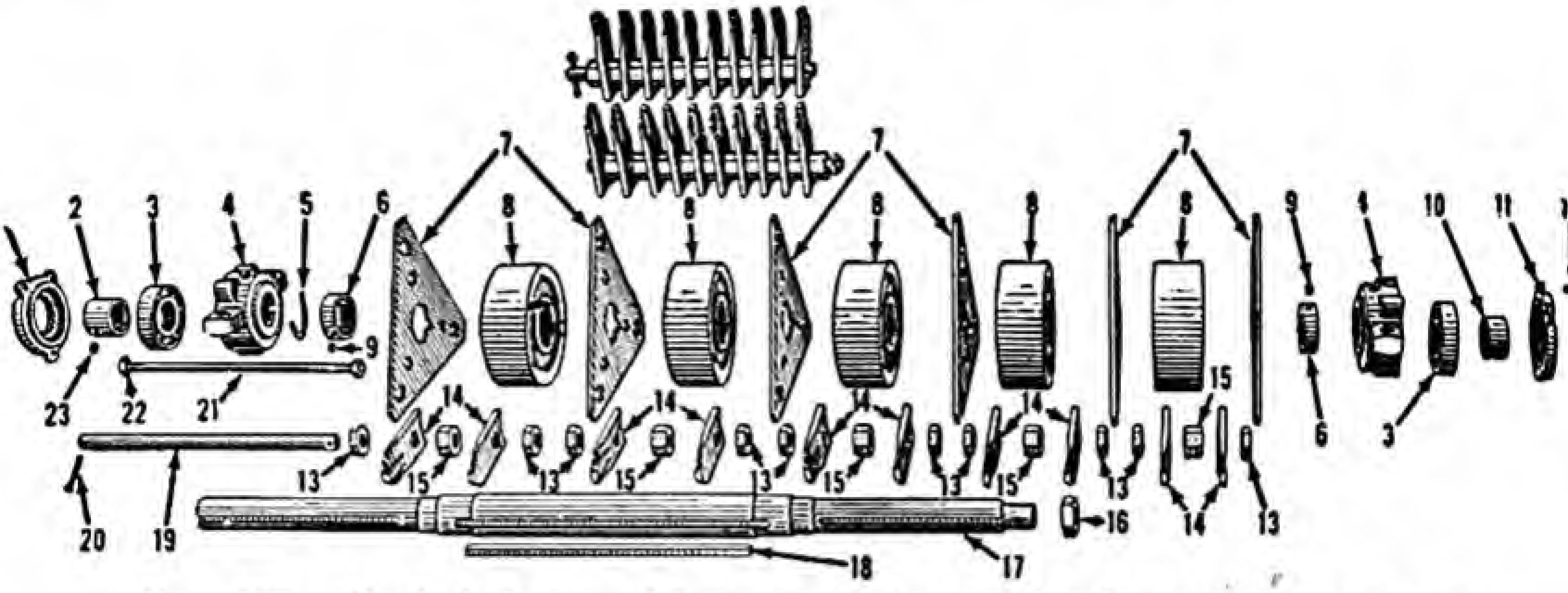


FIG. 608.—Exploded view of hammer-mill rotor showing component parts.

502. Sizes.—Hammer-mill feed grinders vary in size from the small compact mill with a direct-connected 1-horsepower electric motor (Fig. 609) to the large mill requiring 75 to 100 horsepower to operate it (Fig. 611). When a feed hopper is attached to the mill it will automatically feed itself and requires no attention. Figure 610 shows a typical installation. Such a mill is well suited for use where rural electric service is available.

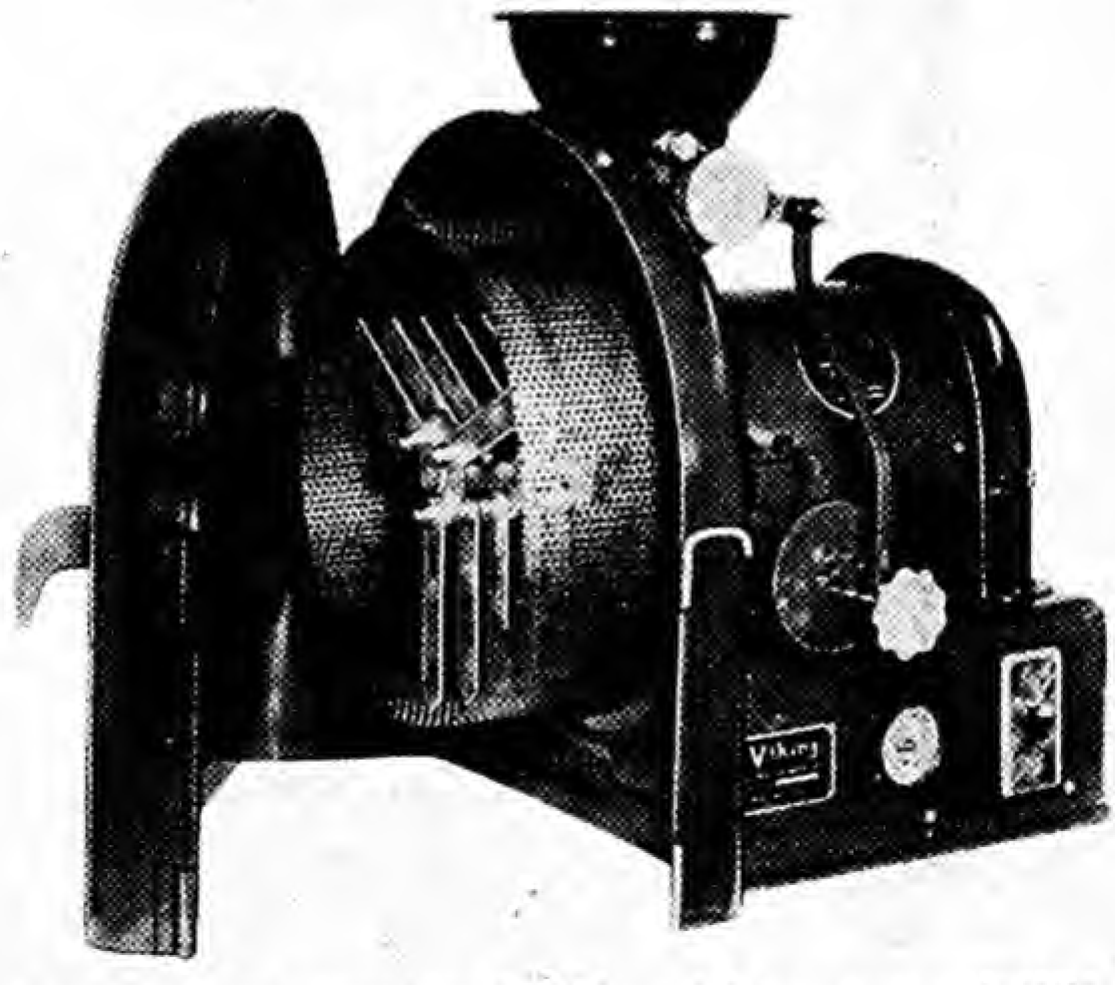


FIG. 609.—Small hammer mill equipped with a 1-horsepower electric motor which is direct-connected to the grinder.

503. Hammers.—The hammers are fastened on a cylinder and may be rigid or swinging. The swinging hammer is hinged (Fig. 612), but the rigid is fastened to a rotor shaft or cylinder by jam nuts (Fig. 613). The shape of the hammer cutting edge varies according to the ideas of the designers. The hammer should, however, be made of high-grade hardened steel to prevent excessive wear.

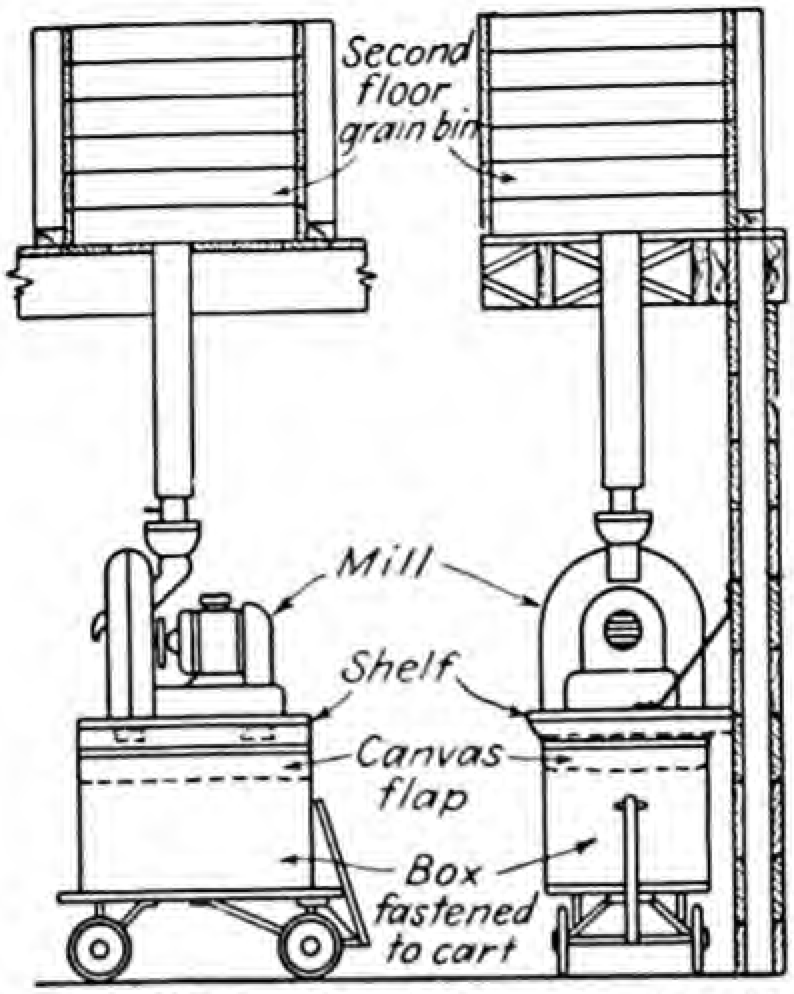


FIG. 610.—Arrangement for automatic grinding of grain with small hammer mill.

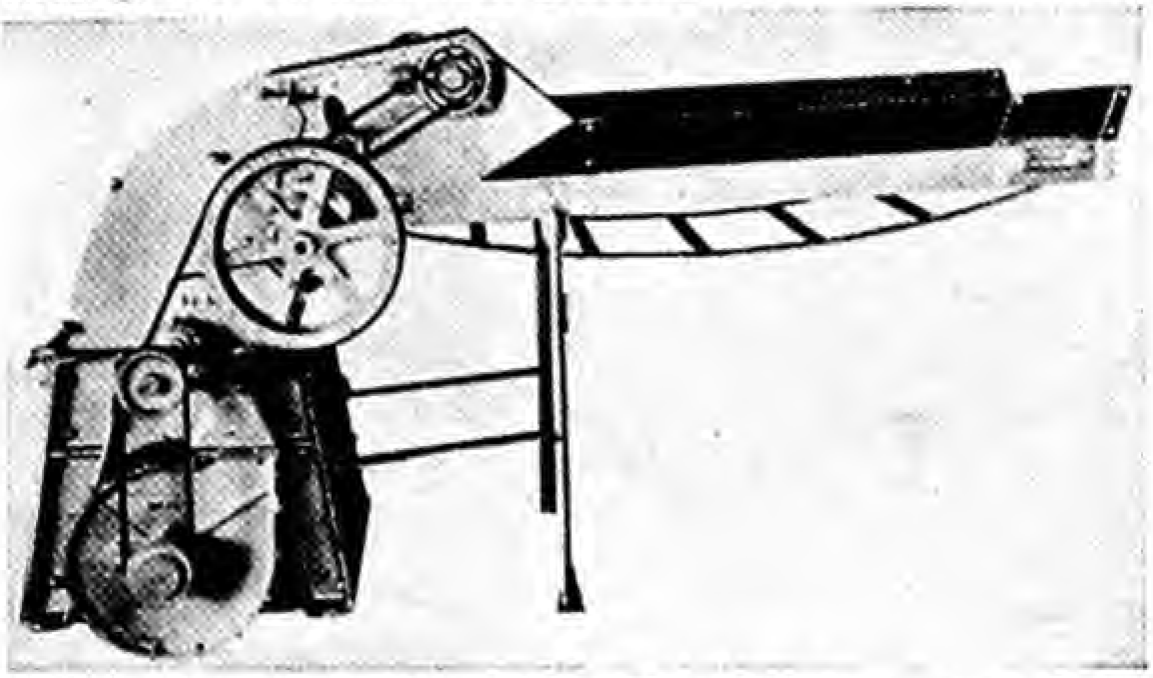


FIG. 611.—Large hammer mill requiring 75 to 100 horsepower for operation.

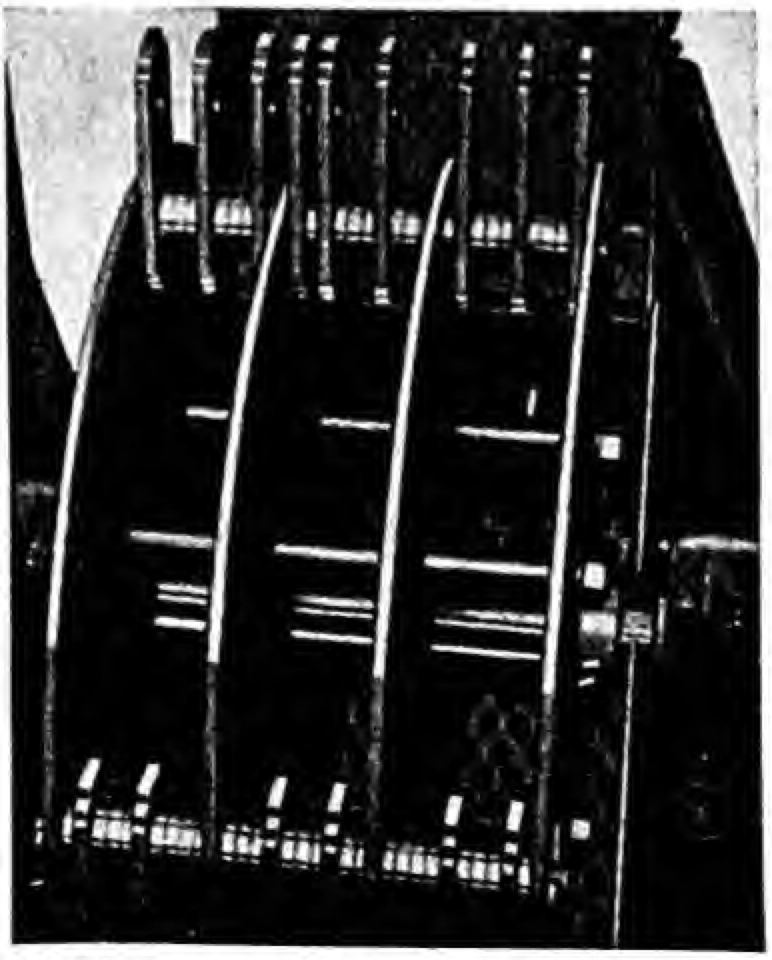


FIG. 612.—Section of hammer mill showing swinging hammers and screen.

504. Screens.—In most machines the lower half of the cylinder is enclosed by a screen, usually of one piece. It usually consists of holes punched through sheet steel, as shown in Figs. 609 and 612. Various-sized holes are used, depending upon the fineness of grinding. The size

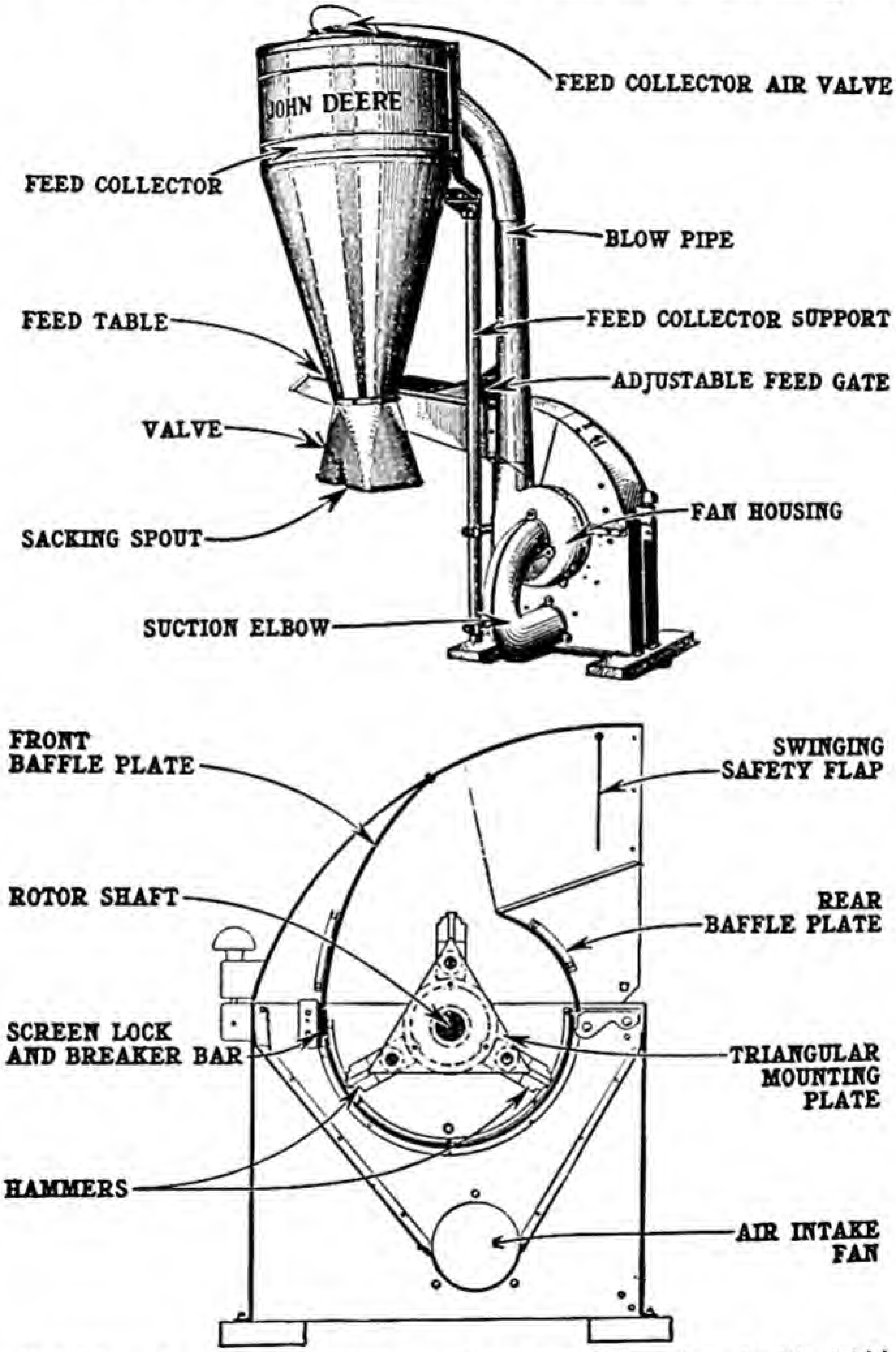


Fig. 613.—Outside and cross-sectional views of hammer mill equipped with rigid hammers.

of the holes ranges from $5/64$ inch to 2 inches. The smaller holes are used when grinding grains, while the larger sizes are used when grinding roughage, such as sorghum stalks, cornstalks, or hay.

505. Grinding Process.—The material to be ground is fed directly into the compartment where the hammers are revolving. The hammers

strike the material with such violent force that it is practically exploded. The material is retained on the screen until it is beaten fine enough to pass through the perforations.

Table XIX.—Capacity and Horsepower Requirements of Hammer Mill in Grinding Different Feeds at Different Speeds[1]

Specifications:
- Type—double reduction with knives and flexible hammers.
- Width of grinding cylinder—8¾ inches.
- Width of screen—8¼ inches.
- Diameter of grinding cylinder—31½ inches.
- Recommended speed—1,800 r.p.m.
- Special equipment—fan-type bagger with dust collector.
- Weight—970 pounds.

Size of screen, inches	Mill speed, revolutions per minute	Pounds ground per hour	Kilowatt-hour per 100 pounds	Power input to motor, kilowatts	Horsepower required by mill	Fineness modulus
		No load				
	1,590	(Without fan)		2.24	2.00	
	1,590	(With fan)		2.78	2.60	
	1,930	(Without fan)		2.90	2.80	
	1,930	(With fan)		3.80	3.90	
	2,425	(Without fan)		4.94	5.25	
	2,425	(With fan)		6.85	7.60	
		Snapped corn				
½	1,514	1,324	0.70	9.25	10.10	3.75
		Bundled hegari				
¼	1,540	1,012	0.97	9.82	10.60	3.10
½	1,545	1,398	0.61	8.55	9.42	3.28
1	1,568	1,670	0.46	7.54	8.32	3.92
		Alfalfa hay				
¼	1,548	1,401	0.55	7.73	8.56	2.41
½	1,581	1,363	0.46	6.09	6.70	
1	1,578	2,272	0.28	6.29	6.95	2.95

Note: Century motor used in all tests.

[1] Report of Farm Electrification Short Course at the Agricultural and Mechanical College of Texas, 1931.

506. Capacity and Power.—The capacity of a hammer mill also depends to a large extent upon the rate of feeding, speed of hammers,

power available, kind of material being used, fineness of grinding, size of opening in screen, and size of mill.

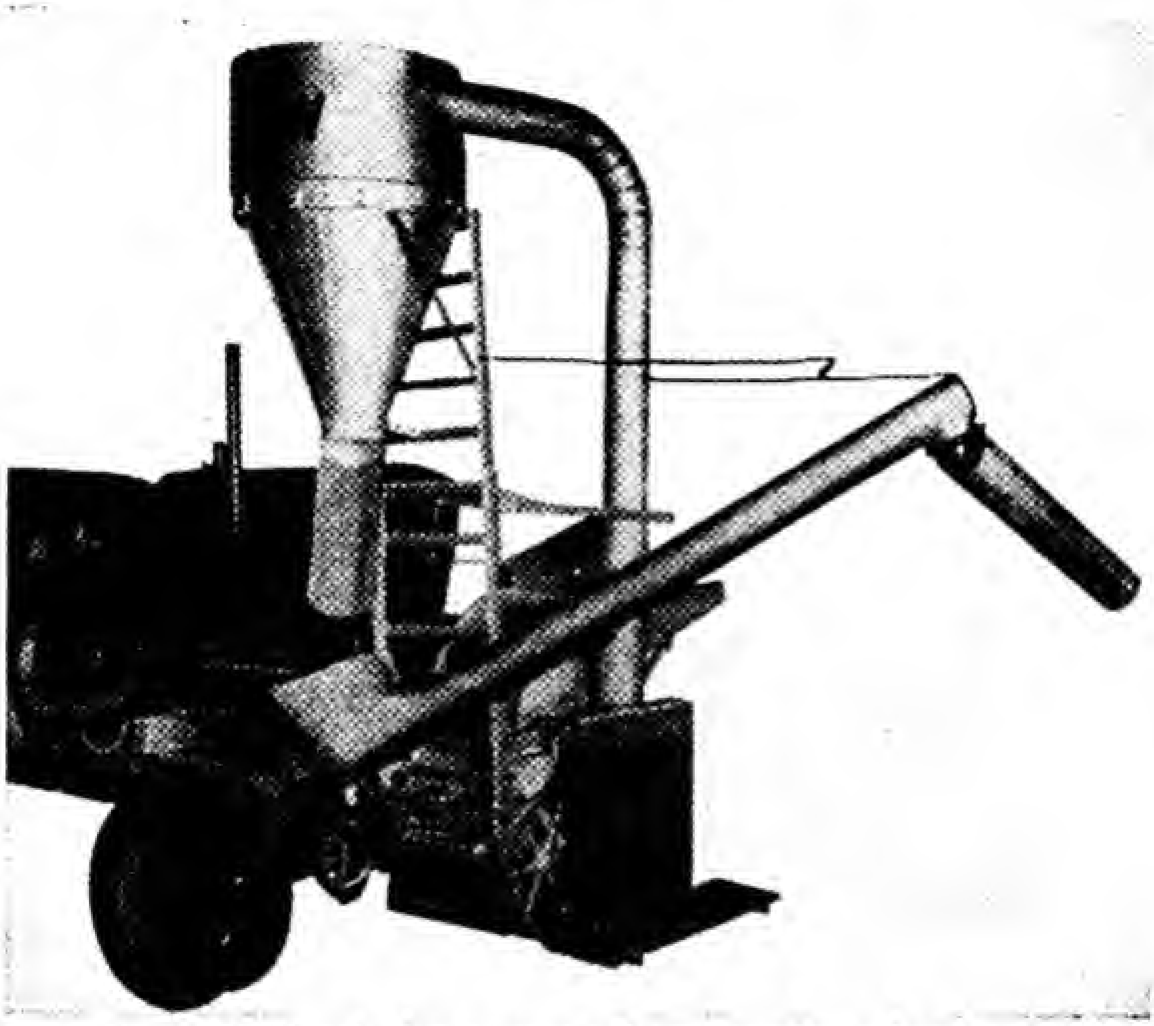


FIG. 614.—Hammer-type feed grinder mounted on truck and operated by industrial-type engine.

Table XIX shows the results of tests made by Jones of the Agricultural and Mechanical College of Texas on a hammer mill. Vutz[1] states that the capacity for a given fineness and horsepower is limited by the size of the screen.

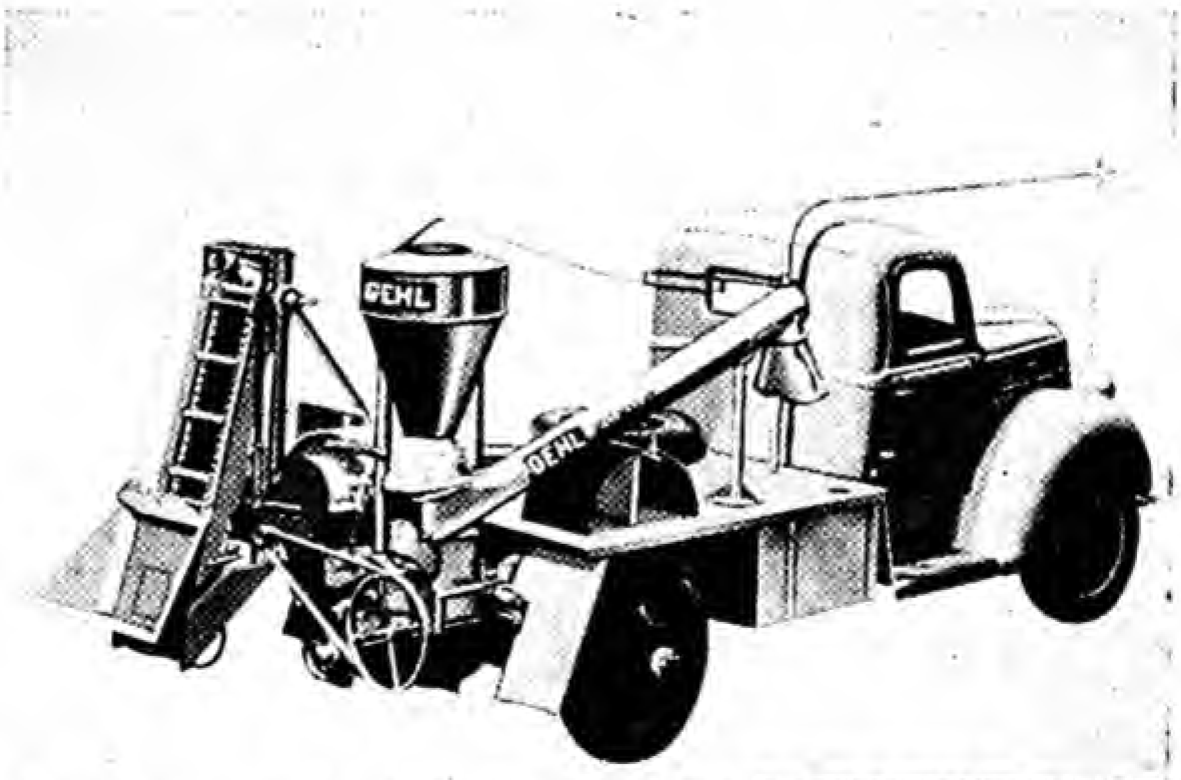


FIG. 615.—Feed mill mounted on truck and operated by truck engine through special transmission.

507. Elevating Attachments.—The ground feed is removed from under the mill by suction and blown into the large collector hopper, equipped

[1] *Agr. Eng.*, Vol. 12, No. 7, p. 271, 1931.

with either a bagging attachment or a swivel spout for delivery into a truck or trailer. The ground material may also be blown directly into the bin. This eliminates most of the dust resulting from the grinding of the feed.

508. Portable Grinders.—Where a farmer wishes to do custom grinding he can mount a hammer feed grinder on a truck so that it can be easily transported from farm to farm with little lost time. Figure 614 shows a grinder mounted on a truck and operated by an industrial-type engine. In Fig. 615 the feed mill is driven by the truck engine through a special transmission.

THE COMBINATION GRINDER AND ROUGHAGE CUTTER

The combination feed-grinder mills have some form of cutterhead and may have either burrs or hammers for the final grinding of the feed. This

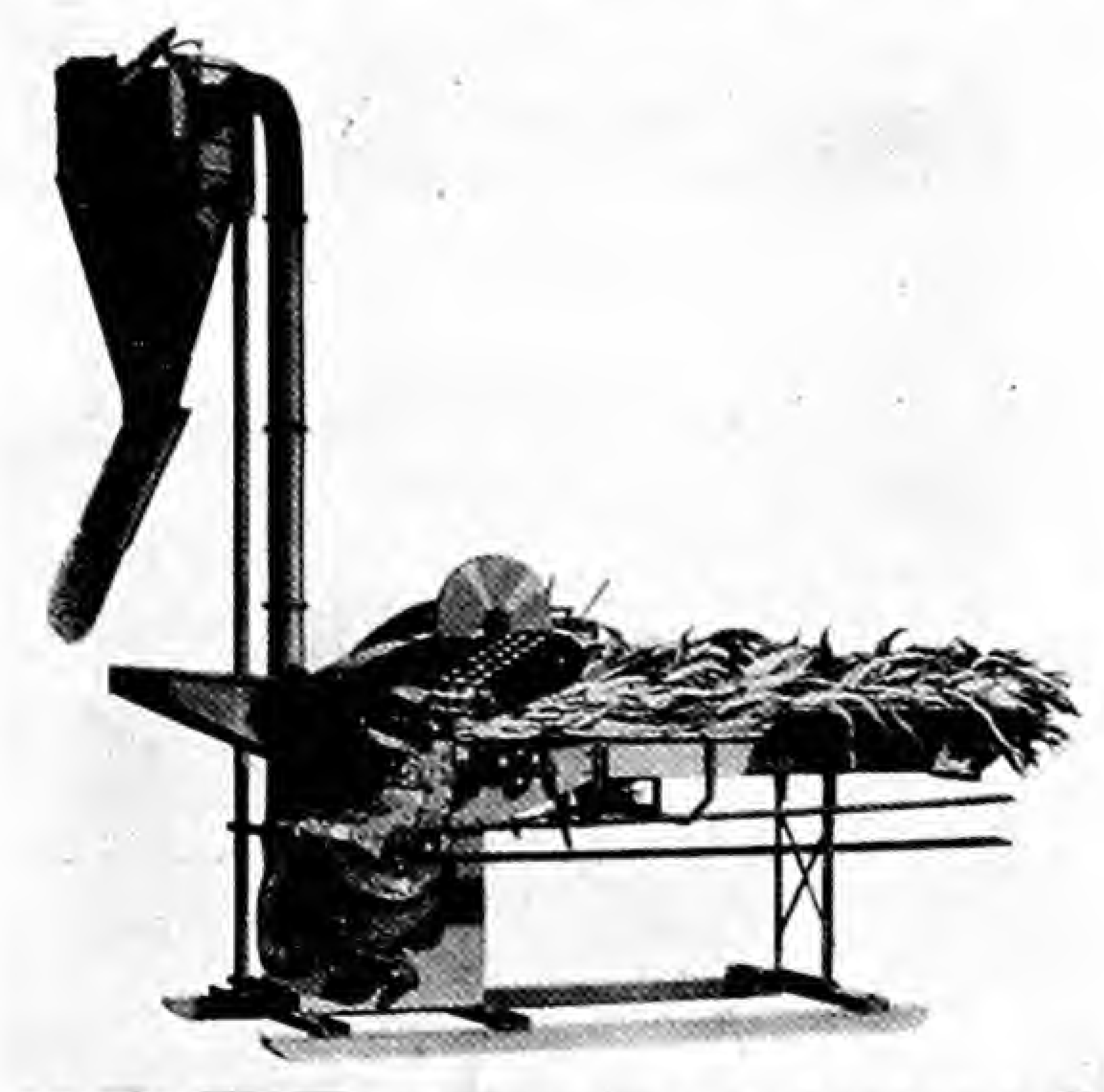


Fig. 616.—Combination roughage mill and feed grinder.

type of mill is suitable for grinding concentrates and roughages separately or in combination. The mills shown in Figs. 616 and 617 are capable of cutting and grinding roughage feeds. Figure 618 shows a combination hammer mill and roughage cutter.

The process of grinding hay or stalk roughage starts with the chopping up of the material by the cutter, as shown in Figs. 616 and 618. The chopped material can be either run out as chopped feed, or it can be run through the burrs and ground into meal. If desired, the concentrates

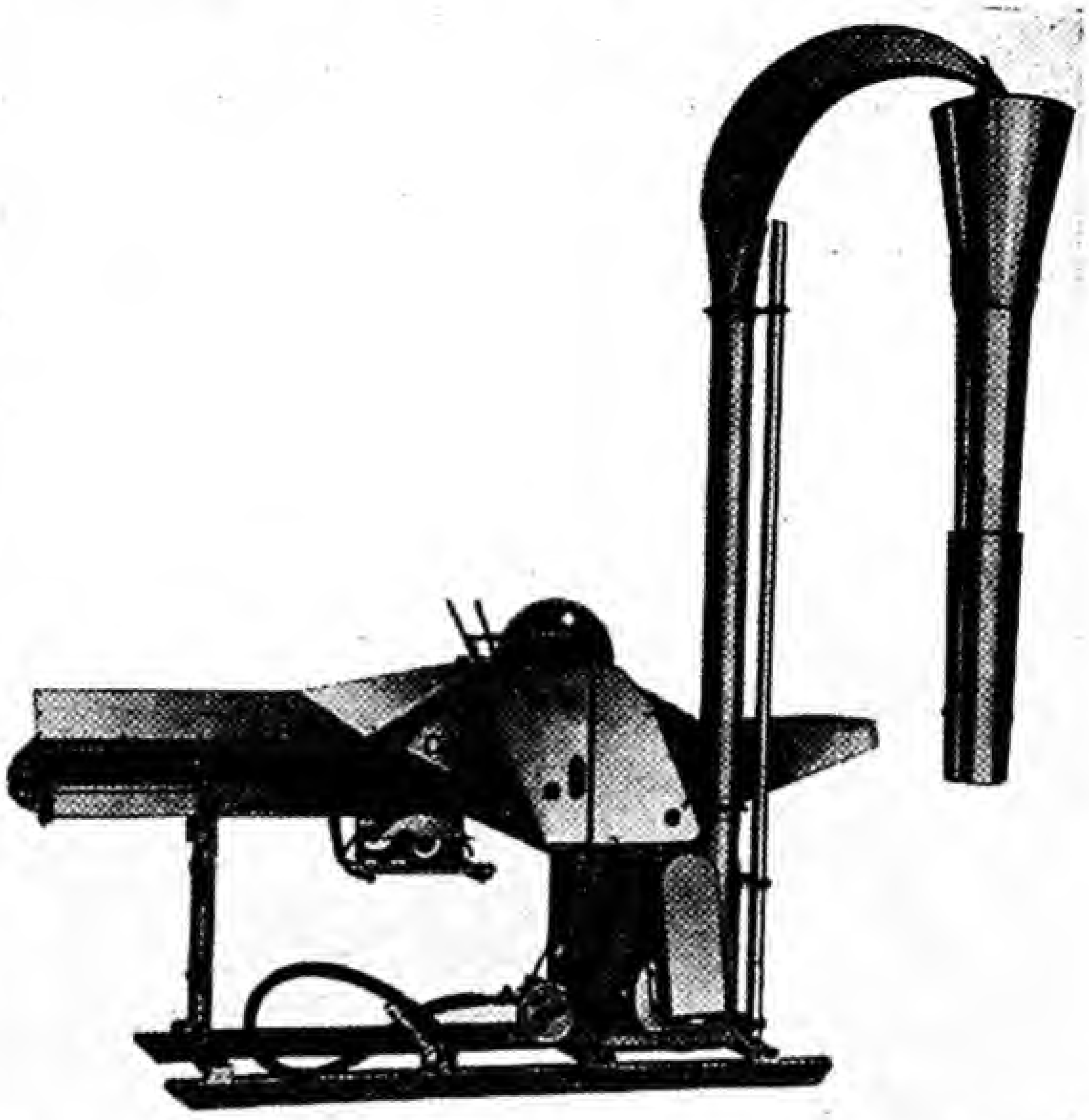


FIG. 617.—Combination roughage cutter and hammer mill, equipped with molasses pump.

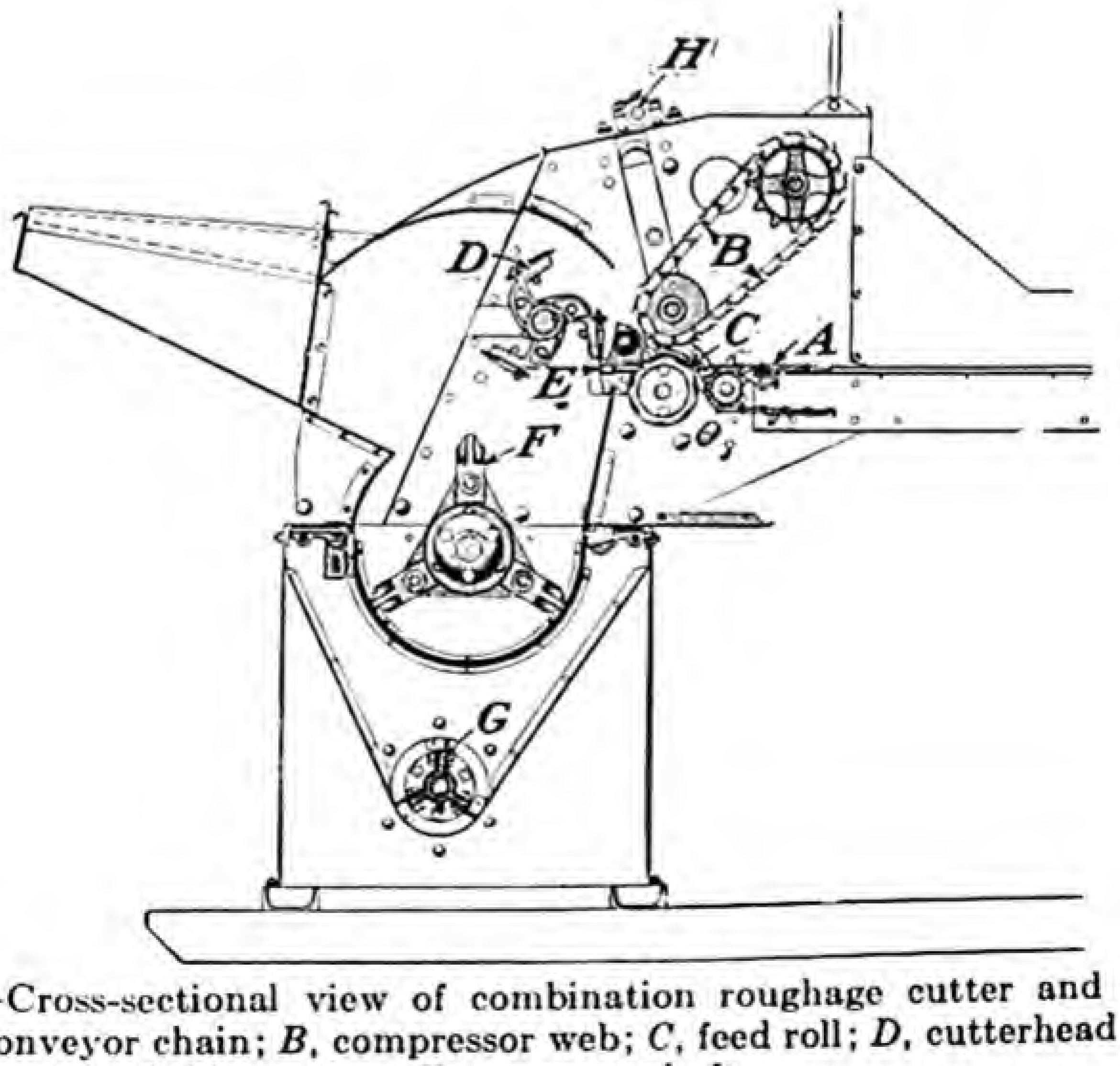


FIG. 618.—Cross-sectional view of combination roughage cutter and hammer mill: *A*, feed-table conveyor chain; *B*, compressor web; *C*, feed roll; *D*, cutterhead; *E*, shear bar; *F*, hammers on rotor; *G*, blower fan; *H*, governor shaft.

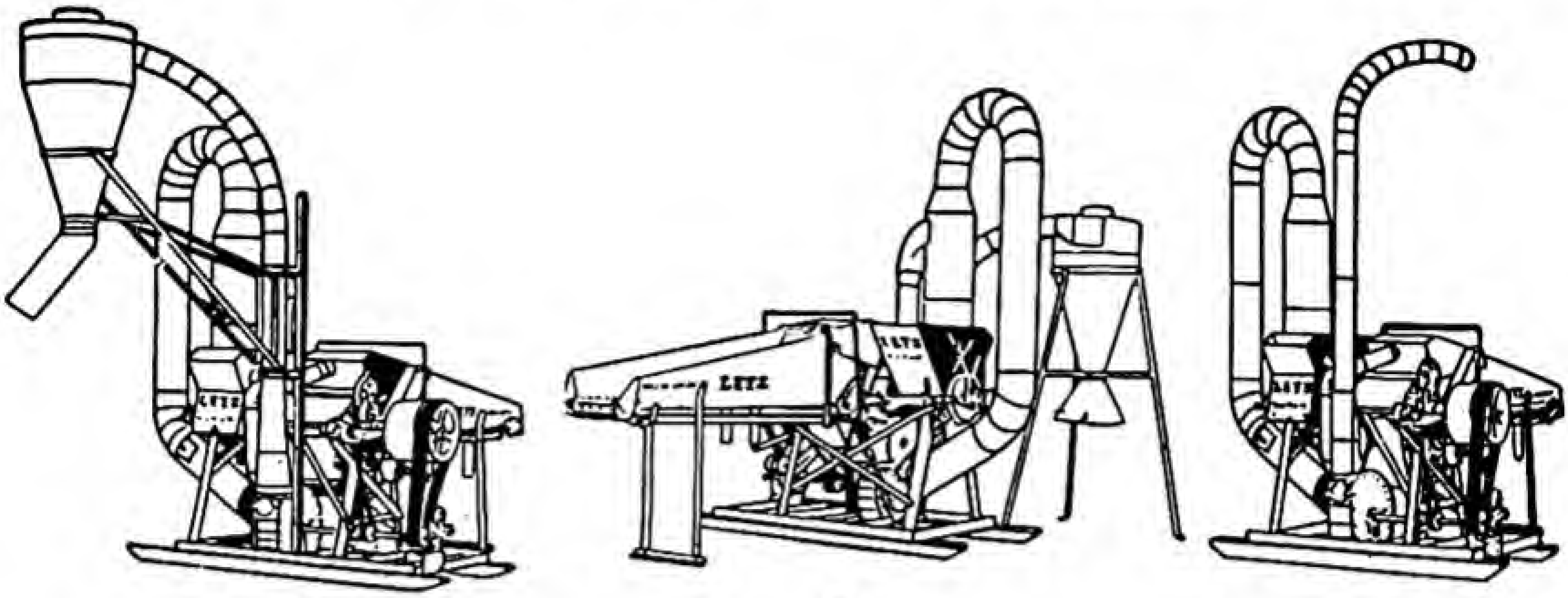
such as corn, sorghum, wheat, or oats can be ground between the burrs and mixed with the chopped roughage as a complete feed. Table XX shows the results of tests made by Jones of the Agricultural and Mechanical College of Texas on a small combination burr mill and roughage cutter.

TABLE XX.—CAPACITY AND HORSEPOWER REQUIREMENTS OF COMBINATION BURR MILL AND ROUGHAGE CUTTER

Specifications:
- Type—combination knife and burr.
- Width of cutting cylinder—9 inches.
- Diameter of burrs—8 and 10 inches.
- Recommended speed—600 to 850 r.p.m.
- Special equipment—self-feed device and chain-conveyor-type sacking elevator.
- Weight—1,045 pounds.

Size and kind of burrs	Mill speed, revolutions per minute	Pounds ground per hour	Kilowatt-hour per 100 pounds	Power input to motor, kilowatts	Horsepower required by mill	Fineness modulus
			No load			
	435			1.40	1.05	
	511			1.40	1.05	
	563			1.60	1.30	
			Snapped corn			
8″ coarse	410	1,296	0.53	6.82	7.00*	3.98
8″ coarse	419	1,174	0.51	5.93	6.22*	3.88
8″ coarse	520	1,178	0.62	7.33	7.45*	3.56
8″ coarse	675	1,250	0.69	8.62	9.45†	3.55
8″ coarse	790	1,120	0.72	8.10	8.95†	3.34
			Bundled hegari			
8″ coarse	490	893	0.65	5.81	6.15*	3.79
8″ coarse	530	1,083	0.46	4.96	5.33*	3.77
8″ coarse	675	1,100	0.51	5.58	6.10†	3.15
10″ coarse	405	1,023	0.65	6.60	6.82*	3.87
10″ coarse	484	1,435	0.50	7.05	7.78†	
Cutting only	530	1,868	0.23	4.10	4.43	4.45
			Alfalfa hay			
8″ coarse	530	878	0.32	2.77	2.83	
8″ coarse	685	867	0.55	4.70	5.02	

* General Electric motor used.
† Century motor used.



A B C

FIG. 619.—Three methods of handling ground material from roughage mill: *A*, tower, collector and pipe for delivery into truck or trailer; *B*, collector with bagging attachment; *C*, fan and pipe for delivery into barn or bins.

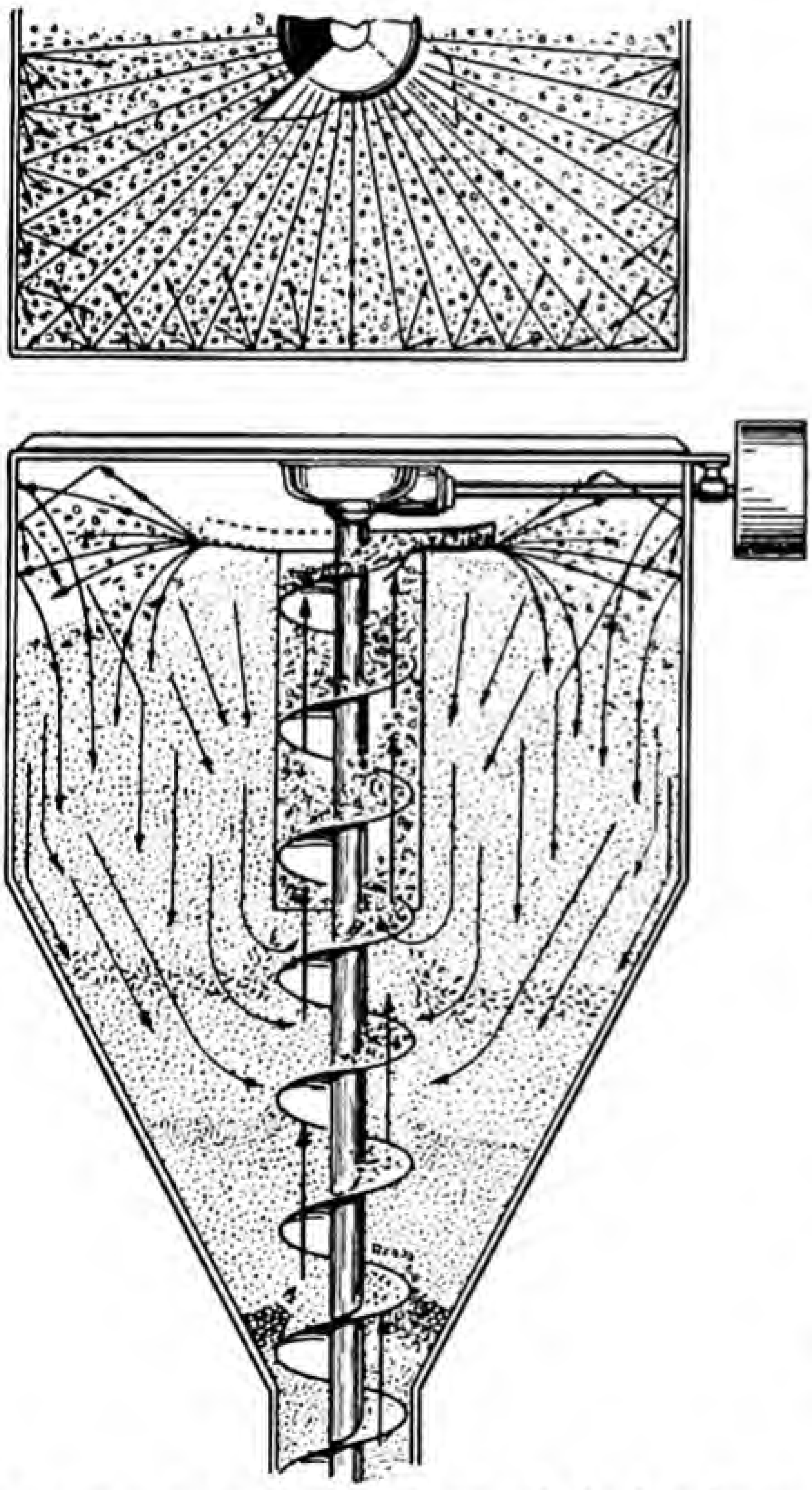


FIG. 620.—Sectional views of feed mixer: *top*, overhead view; *bottom*, side view.

FEED MIXERS

Where farmers wish to mix two or more ground feeds of known feeding value to obtain a balanced ration feed, a feed-mixing machine is needed (Fig. 620).

509. Adding of Molasses to Feed.—If molasses is to be mixed with the feed, a special molasses pump is required to pump the molasses from a barrel and inject it into the housing of the feed mill so that the molasses is automatically mixed with the feed as it is ground and blown from the housing of the mill (Fig. 621).

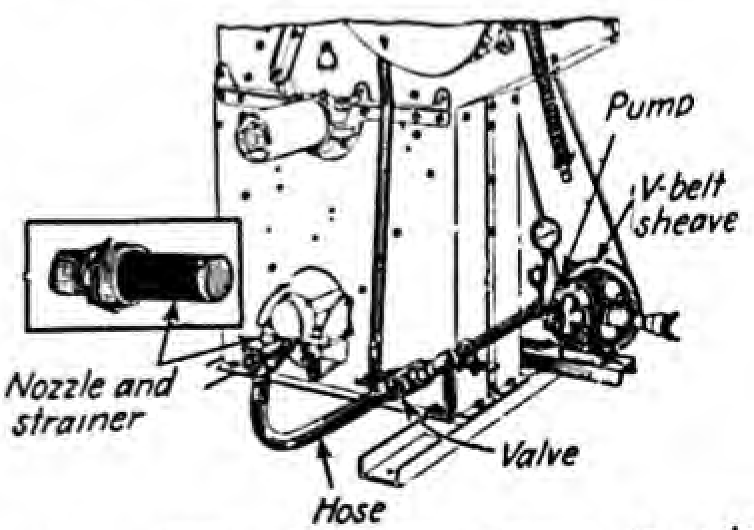


FIG. 621.—Molasses pump to mix molasses with ground or chopped green feed.

CHAPTER XXVIII

SILAGE CUTTERS AND HARVESTERS

Beef and dairy cattle and other types of livestock will remain in better condition during the winter months if they receive a succulent feed. As there are no green pastures in the winter, such feed must be grown, harvested, processed, and preserved in a silo so that it will be available when needed. In the Northern states corn is the principal silage crop, while in the Southwest sorghum is used more than corn. The use of grasses for silage is growing in popularity in some areas.

The former method of putting up silage was to cut and bundle the crop with a row binder and then haul the bundles of stalks to the silo where they were chopped up and blown into the silo. The silo may be either an upright round cylinder 20 to 40 feet in height or a long trench dug in the ground. The trench may be 8 to 12 feet wide at the top and 30 to 60 feet in length, the size depending upon the tonnage of silage to be put up. A few pit silos may be found.

There are two types of machines for processing silage. One type is used as stationary equipment at the silo and is called a *silage cutter*, *ensilage cutter*, or *silo filler*. The other type chops the material as it is harvested and blows it directly into a truck. It is then hauled to the silo and dumped into a blower, which blows the silage into the silo. The field cutters are called *silage harvesters*.

SILAGE CUTTERS

Silage cutters may be divided into two general types, depending on the form of the cutting head. They are the cylinder type (Fig. 622) and the flywheel type (Fig. 623).

Both the cylinder and flywheel types are mounted on trucks so they can be easily moved from place to place. Means are provided for blowing the cut material into the inside of the silo, through a vertical blower pipe. Three distinct operations are performed by the silage cutter: feeding, cutting, and elevating.

510. Size and Capacity of Cutters.—Duffee[1] has collected considerable data to show that the capacity of a silage cutter is directly proportional to the total area of the throat opening, other things remaining the

[1] *Am. Soc. Agr. Eng. Trans.*, Vol. XIX, p. 102, 1925.

same. Some companies are now rating the size of their cutters upon the basis of the total number of square inches in the throat opening.

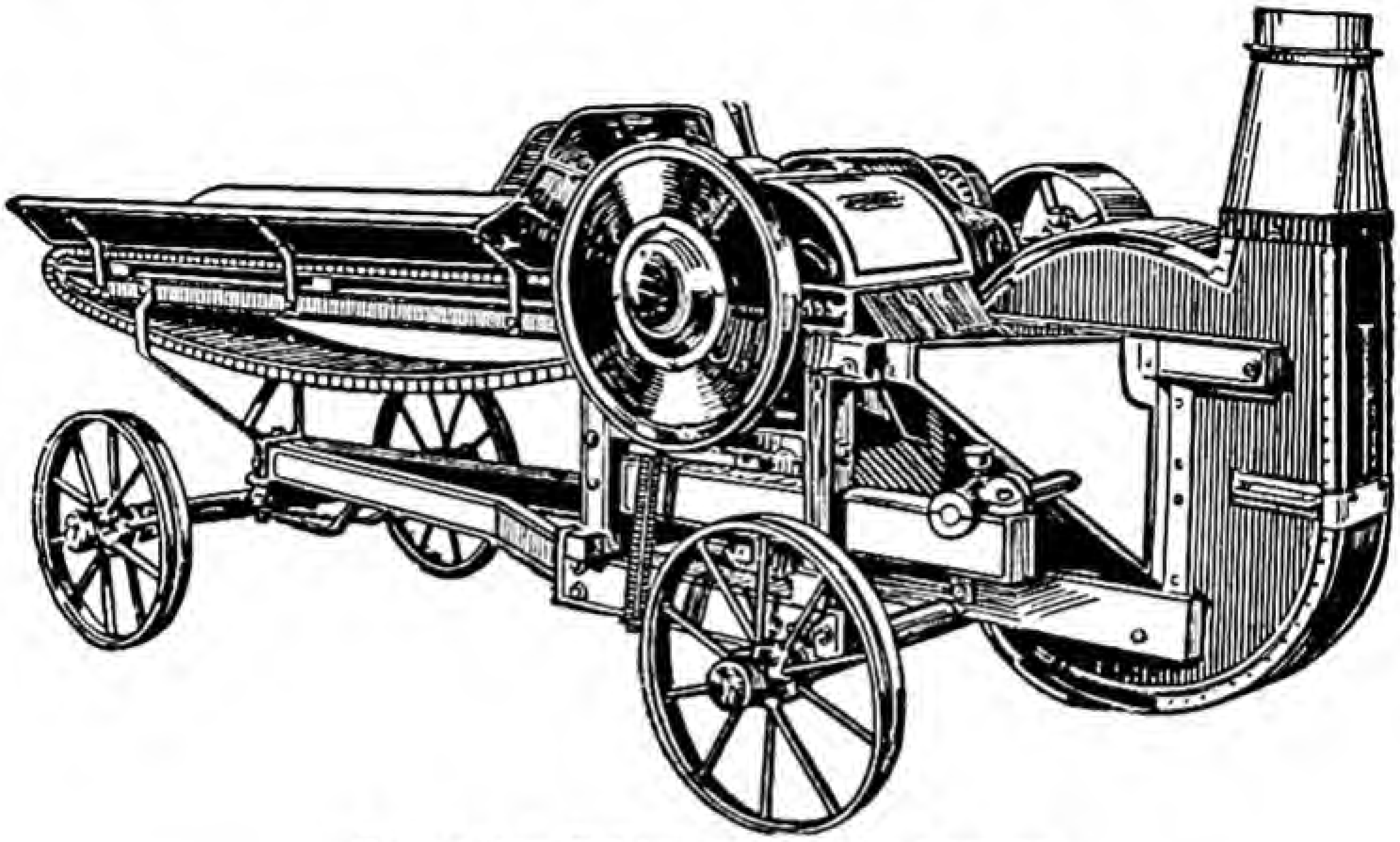


FIG. 622.—Cylinder-type silage cutter.

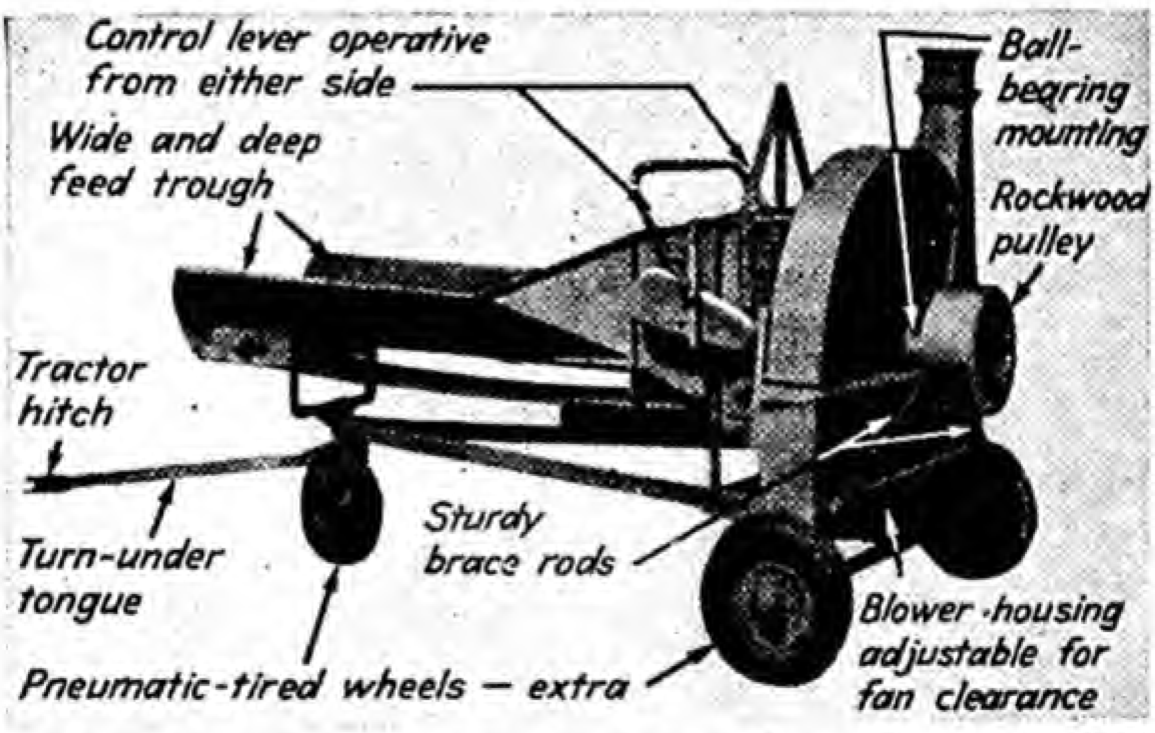


FIG. 623.—Flywheel-type silage cutter mounted on pneumatic-tired wheels.

The formula derived by Duffee to determine the capacity of a silage cutter is as follows:

Capacity in tons per hour equals

$$W \times H \times L \times N \times R \times K,$$

where W = width of throat, in inches measured at narrowest point.
H = height of throat, in inches.
L = length of cut, expressed decimally.
N = number of knives.
R = speed, in revolutions per minute.
K = a constant of 0.00036.

511. Feeding Apparatus.—The proper way to feed a silage cutter is to keep an even stream of material going through the machine at all times. It is always best to feed the stalks into the machine butts first.

The feeding mechanism of a silage feeder consists primarily of the apron and the feed rolls. Some of the smaller cutters do not have a carrier apron but are hand fed.

There are several types of traveling aprons. On some machines *grip hooks* are used to make the feeding more positive. Figure 624 shows a typical feed apron. Both metal and wooden slats are used, but metal are considered the best. A tension device is provided to regulate the tightness of the apron.

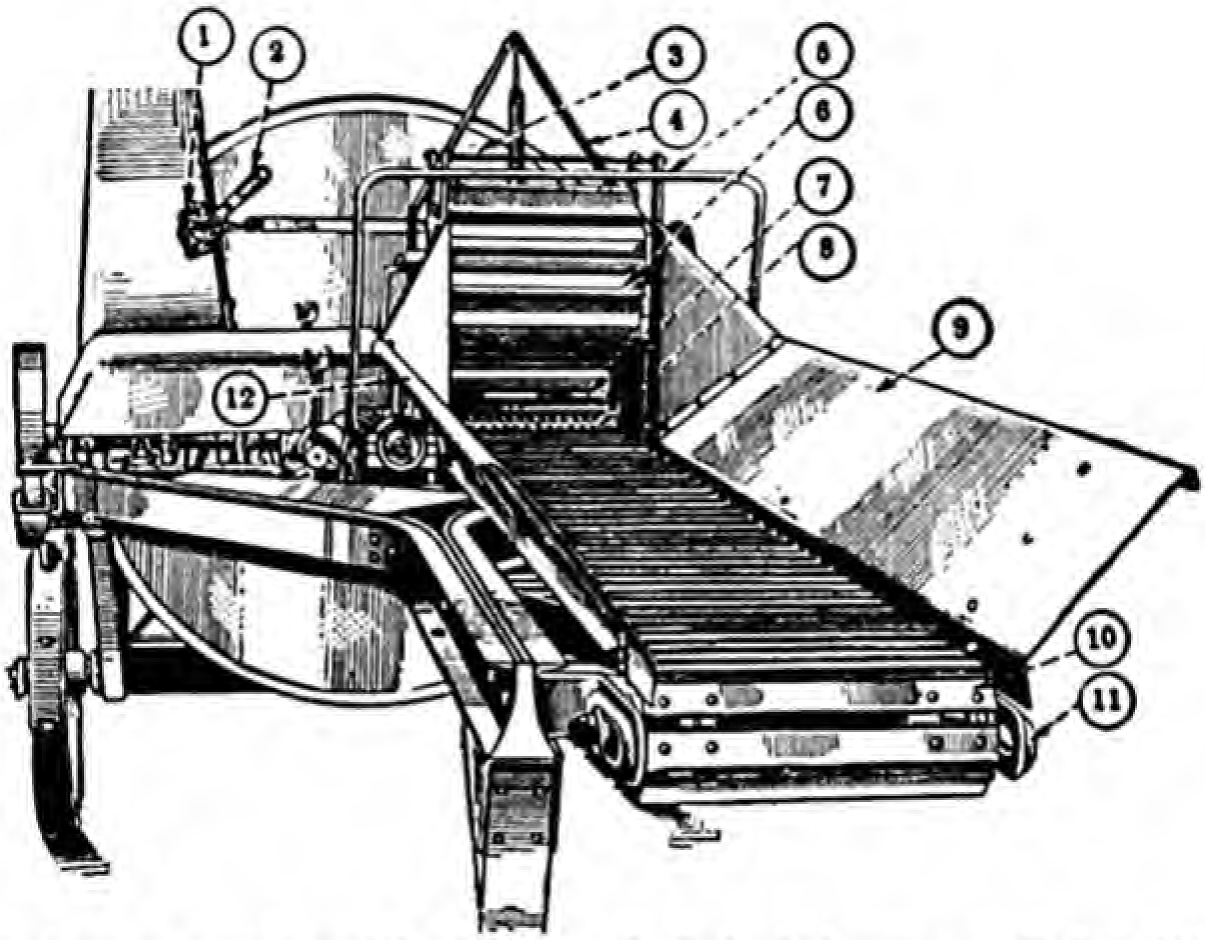


FIG. 624.—Carrier apron and feed rolls: 1, 2, lock for cover; 3, fan cover; 4, spring yoke; 5, clutch and control lever; 6, paddle feed roll; 7, upper feed roll; 8, lower feed roll; 9, table side; 10, carrier slat; 11, adjustment for carrier tension.

Where the bundles are being thrown on the feed apron directly from the wagon, the *corn chute* or *extension table* is of great help. The bundles can be lapped sufficiently to aid materially in feeding.

The feed rolls receive the green material from the apron and present it to the cutting mechanism. The rolls have different shaped surfaces, such as corrugated, fluted, and toothed. The number of rolls in a machine varies from two to four. The top rolls should be adjustable vertically yet have tension enough to assure positive feeding. Tension is provided either by weights or by springs.

Duffee found in his investigations on silage cutters that better and more positive feeding was obtained if the conveyor apron and the surface of the feed rolls travel at the same rate of speed.

512. Length of Cut.—It is often desirable to change the length of cut on silage cutters. The most common lengths for silage ranges from $\frac{3}{8}$ to

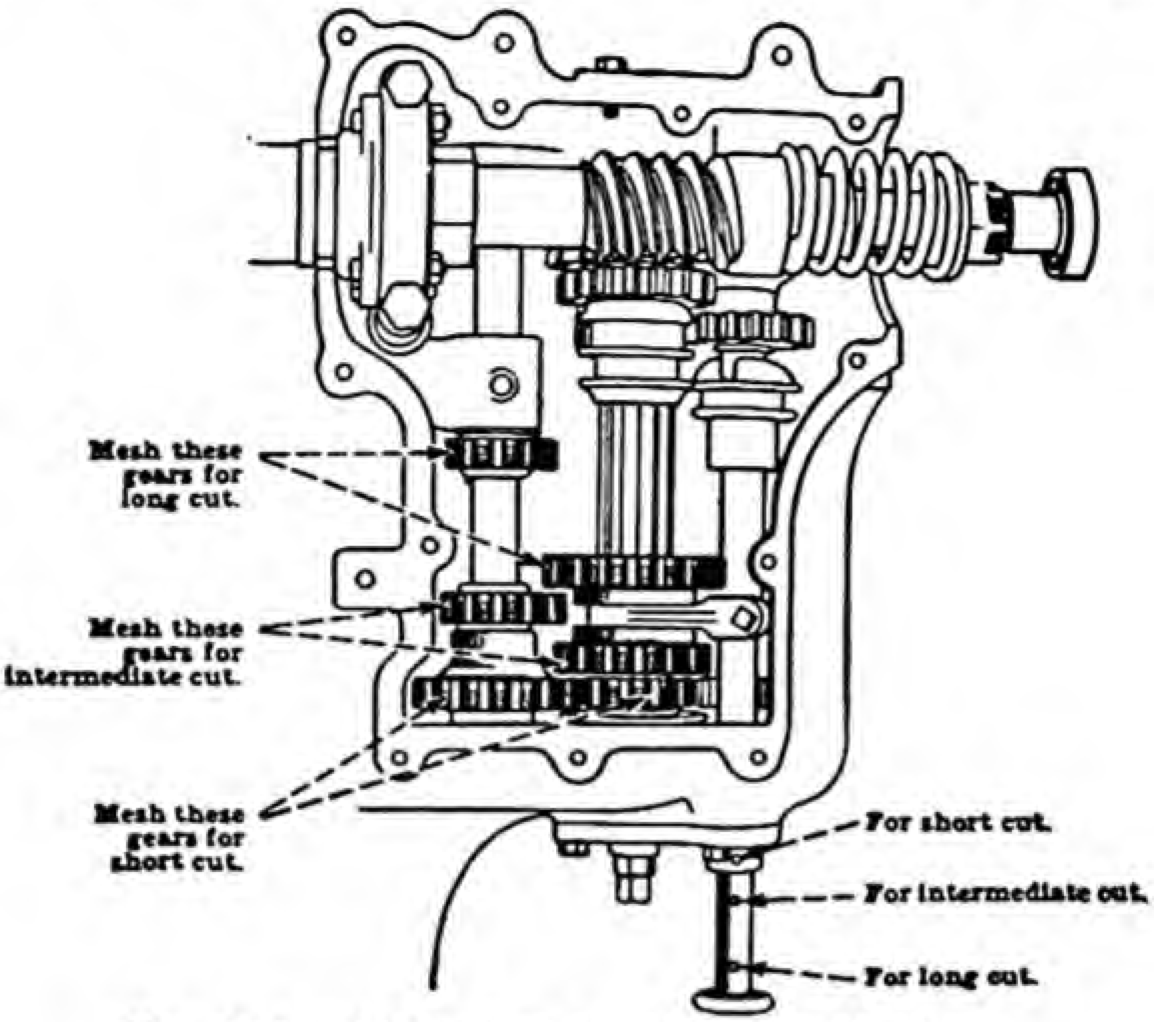


FIG. 625.—Method of changing length of cut.

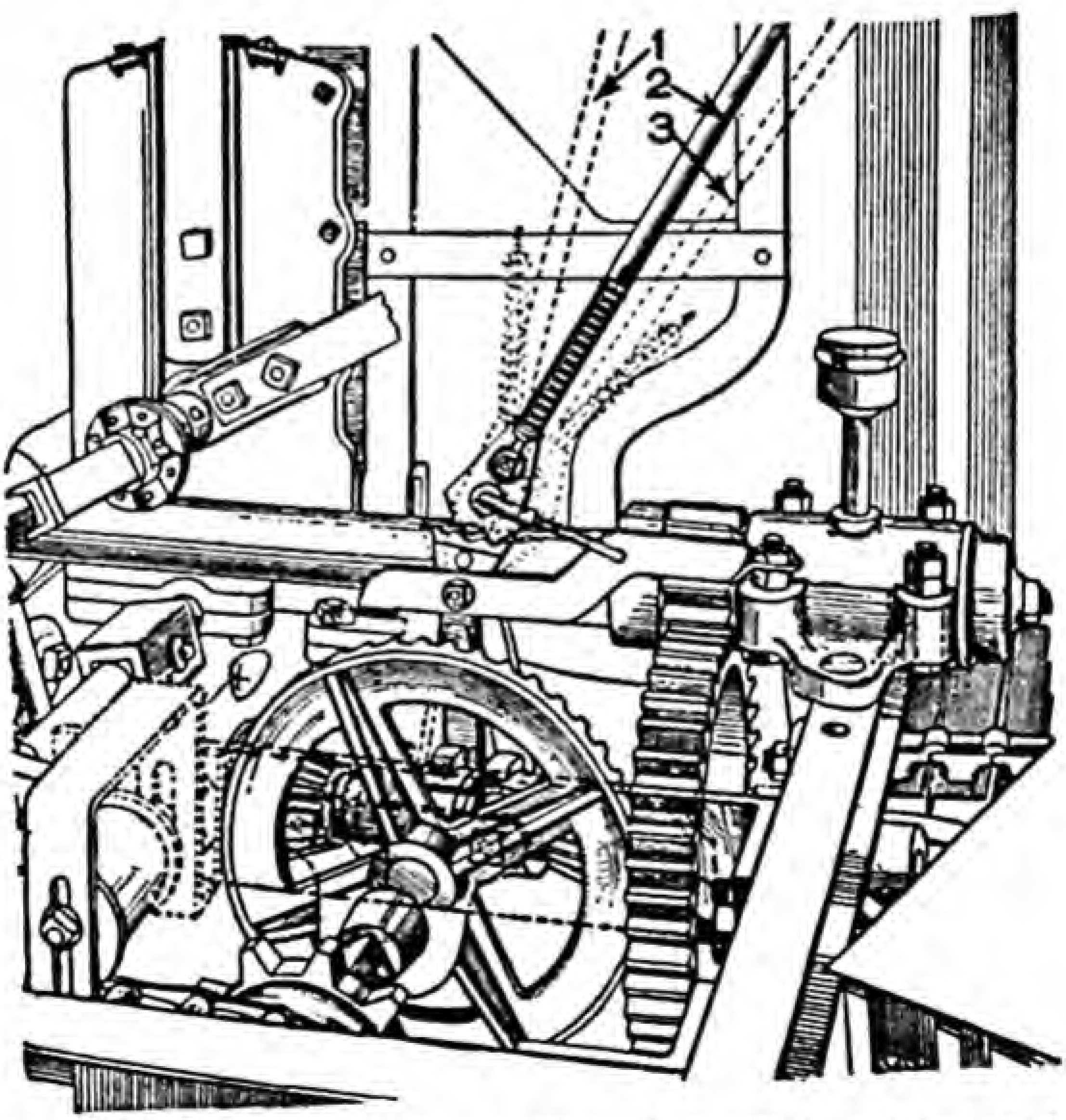


FIG. 626.—Feed-control lever: 1, reverse position; 2, neutral position; 3, forward position.

$\frac{1}{2}$ inch. The length of cut is regulated by the speed of the feed apron and the feed rolls. Faster feeding will give longer cuts, while slower feeding will give shorter cuts.

The speed is changed by changing the gear or sprocket wheel that drives the feeding mechanism (Fig. 625).

513. Feeder Control.—Figure 626 shows a control lever for the feeding mechanism in forward, neutral, and reverse positions. Position

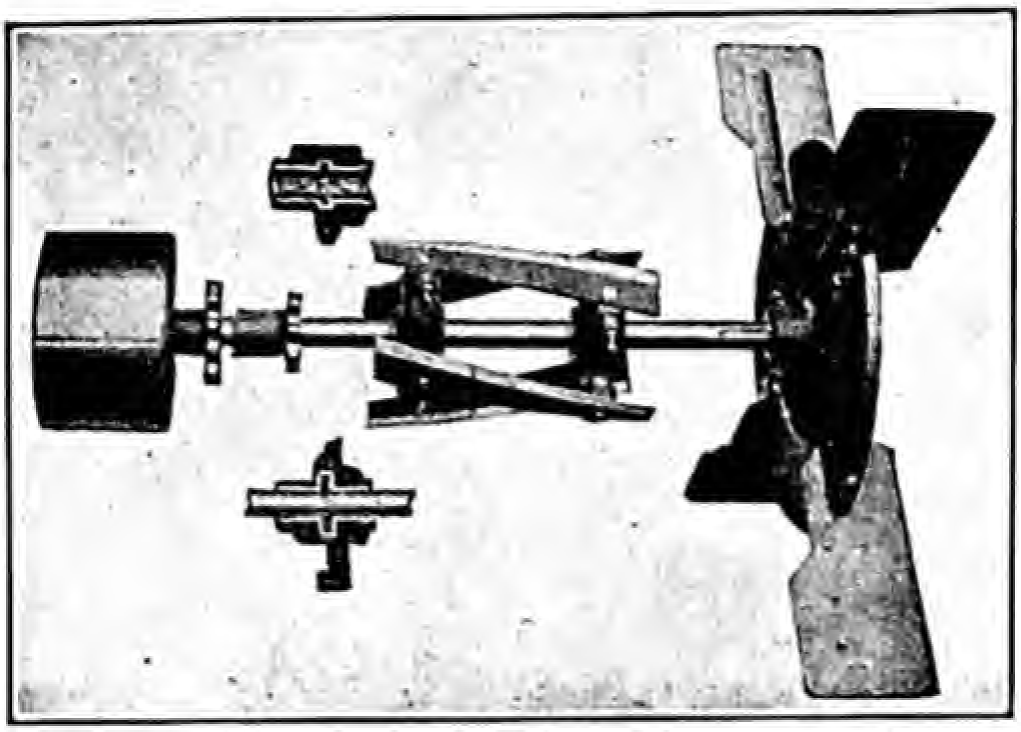


Fig. 627.—Cylinder cutting head, fan, and pulley mounted on the same shaft.

3 is forward or cutting position. Figure 624 shows a lever control that is convenient to both sides of the machine. This provides a safety device,

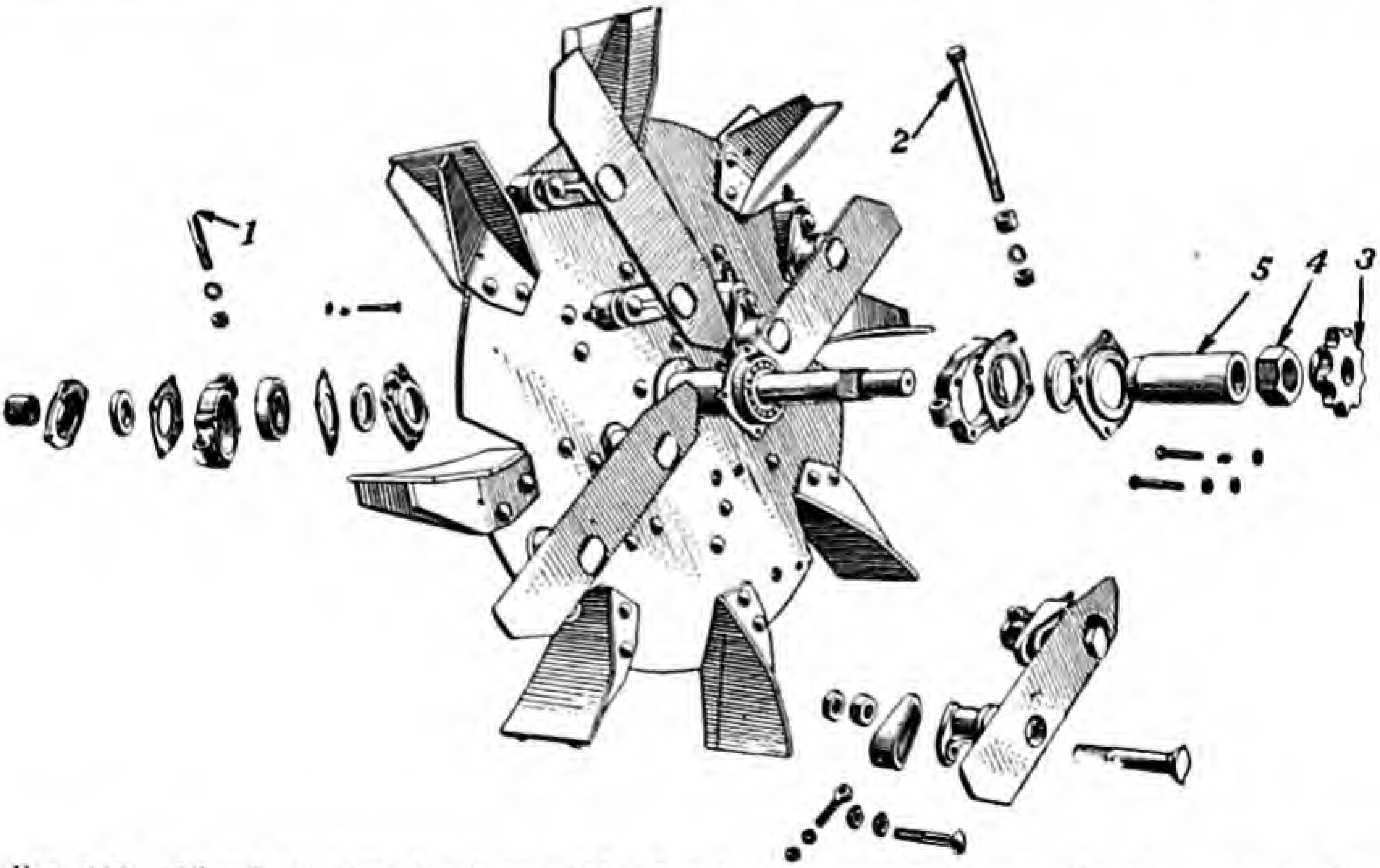


Fig. 628.—Flywheel cutterhead assembly showing component parts of bearings and knife.

since falling against the lever would throw the machine into neutral or reverse position.

514. Cylinder-type Cutting Head.—Figure 627 shows the cutting head of the cylinder type. The number of knives varies from one to four.

They are curved spirally to form a cylinder. The construction is similar to the cutting head of a lawn mower except that it is larger and heavier.

The cutting head of the cylinder type is entirely separate from the blower. It may be mounted on a separate shaft, or it may be on the same shaft, as shown in Fig. 627. When the material has been cut by the knives, it is delivered to the blower by gravity or by an auger conveyor. The speed of the cutting head is from 500 to 600 r.p.m.

The blower, when a separate unit, runs at a speed of 500 to 1,000 r.p.m.

515. Flywheel Type.—The cutting head of the flywheel type consists of a steel or cast-iron flywheel on which are fastened the knives and fan blades (Fig. 628). If the wheel is made of cast iron, it should be reinforced by a steel band or tire around the rim. When a cast-iron wheel is operated at a high speed, there is danger of its exploding or being pulled to pieces, owing to centrifugal force. Under no circumstances should the blower fan housing be opened while the machine is running, as a serious accident might occur. Steel wheels are much safer than cast-iron wheels.

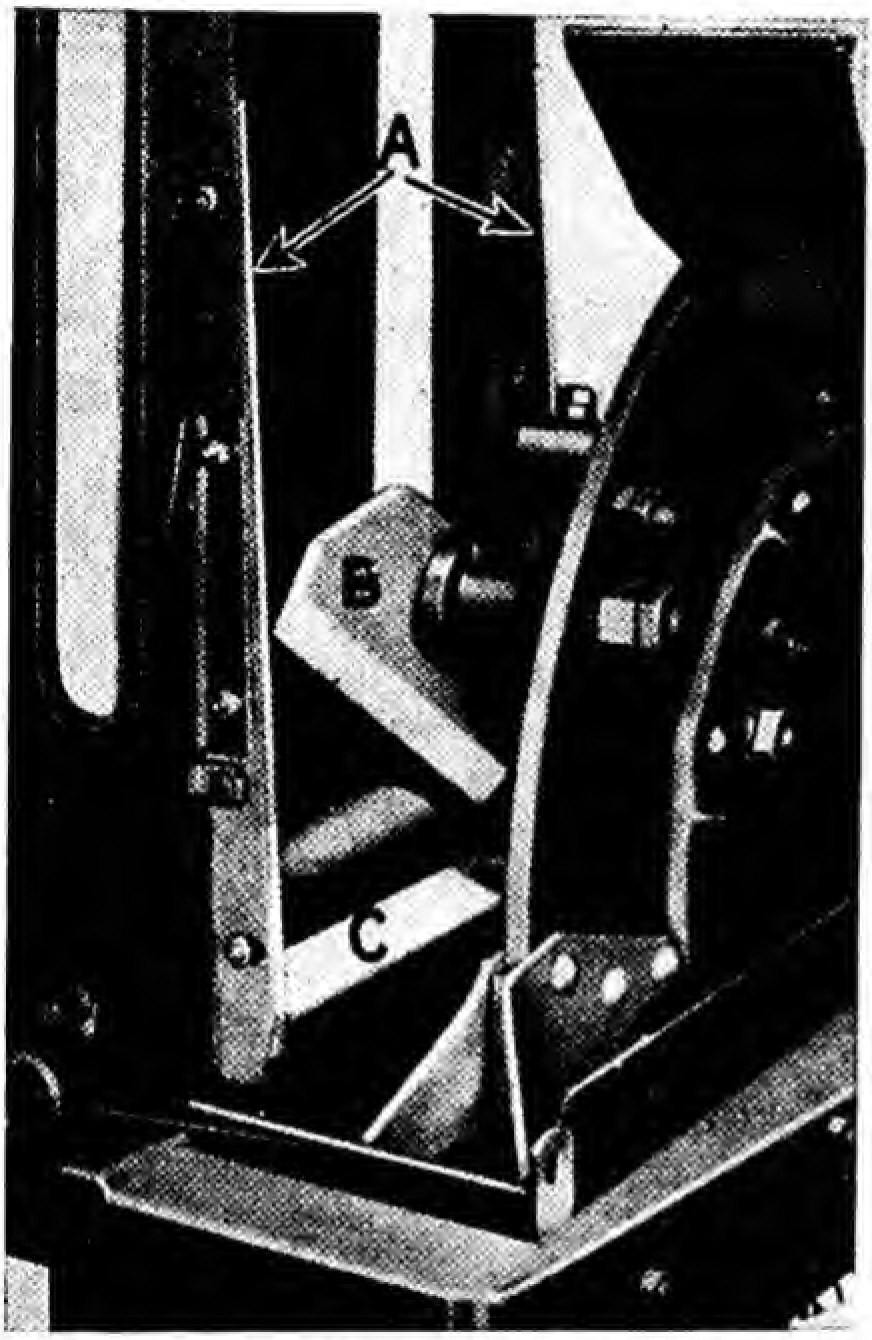


Fig. 629.—*A*, vertical shear plates; *B*, knife; *C*, horizontal shear plate; for flywheel silage cutter.

The shape of the knife used may be either straight, concave, or convex. The straight knife is most often used.

The speed of the cutting head in the flywheel-type cutter is much higher than that of the cylinder type. It ranges from 600 to 1,000 r.p.m.

516. Shear Plate.—The shear plate is also termed the *cutter bar*. This plate, as shown in Fig. 629, forms the other cutting edge for the knives. Some bars are reversible and may have as many as four cutting edges.

517. Knife Adjustment.—Both the cylinder and flywheel types are provided with means whereby the knives can be adjusted to the shear plate. This is done by setscrews and wedges that act on the knife. Additional adjustments may be made with setscrews to line up the

whole cutterhead. For the best cutting the knife should work just as close as possible to the shear plate without striking.

518. Sharpening Knives.—It is very essential that the knives be kept sharp. As a general rule, they should be sharpened after each half day's work. Figure 630 shows a knife-grinding attachment placed on the machine.

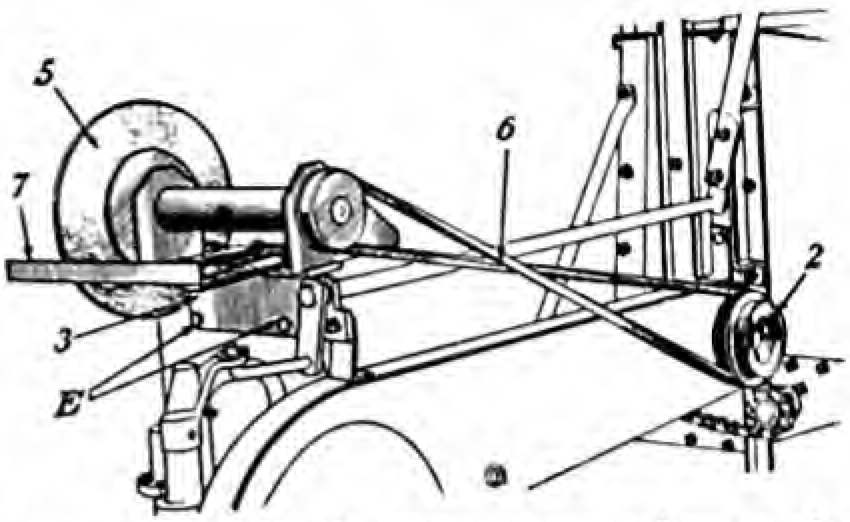


Fig. 630.—Knife-grinding attachment for silage cutters.

519. Elevating and Distributing.—The blower pipe should be set as nearly vertical as possible. If the pipe has very much of an angle, the heavy silage will gravitate to the lower side and let the blast of air pass over and above it. Such a condition would soon cause the pipe to choke. Figure 631 shows a part of the blower pipe with the deflector hood, hopper, and several sections of the distributor pipe. The deflector hood deflects the silage over into the silo. As the silo is filled,

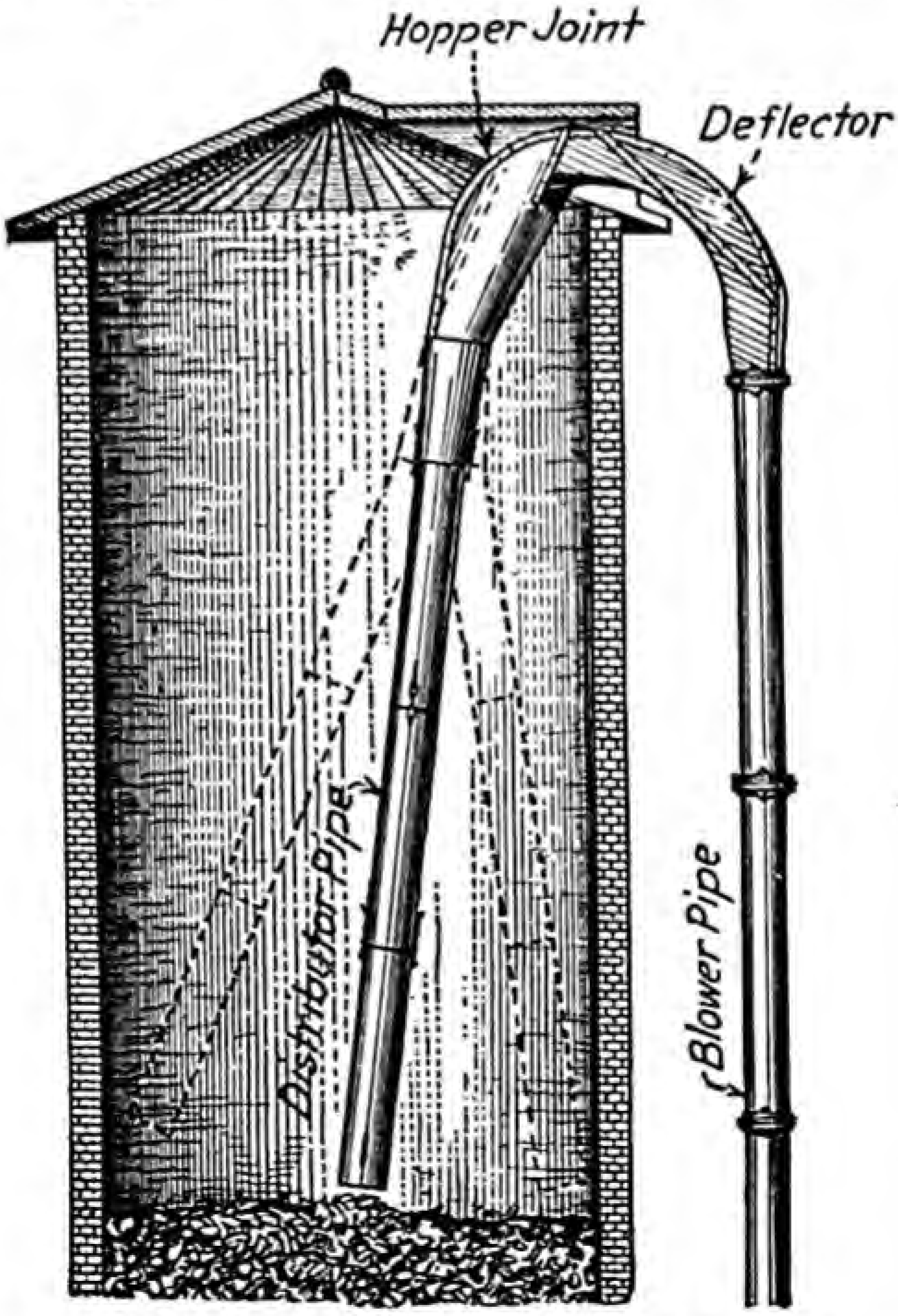


Fig. 631.—Blower and distributor pipe.

sections of the distributor pipe can be removed until the top is reached. The size of the blowpipe varies with the make of the machine and will range from 5 to 8 inches in diameter.

520. Power Requirements.—The power required to operate satisfactorily a silo filler will vary with the size of the machine and the rated speed. Some silage cutters can be operated with a 5-horsepower electric motor, while others require a tractor capable of delivering 30 to 40 horsepower to the belt pulley. There are only a few machines, however, that require more than 20 horsepower to operate them.

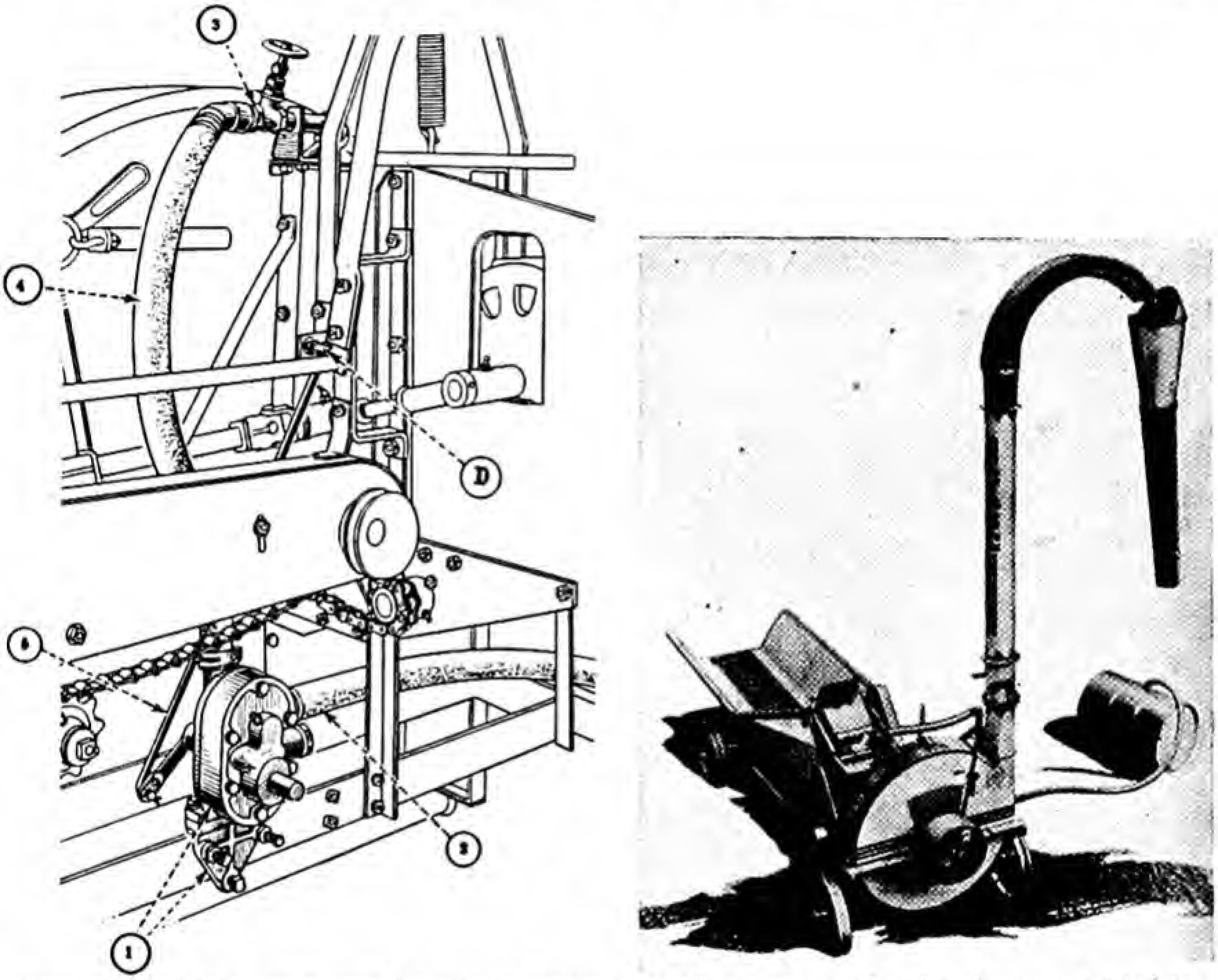


FIG. 632.—Molasses pump for silage cutter, *left;* silage cutter showing hose connected to barrel of molasses, *right.*

521. Addition of Molasses.—It is desirable to add molasses to certain types of feed as it is placed in the silo. Figure 632 shows details of the pump arrangement.

FIELD SILAGE HARVESTERS

The silage harvester performs the functions of both the row binder and the silage cutter, as it severs the standing stalks from the ground and chops them into silage in one continuous operation in the field. It does, however, require a blower at the silo.

There are at least ten advantages for the field silage cutter. They are as follows:

1. Eliminates the drudgery of lifting and loading 10 to 15 tons of heavy green bundles of corn per acre.
2. Provides ensilage at lower cost.
3. Provides more tons of feed per silo.
4. Permits filling the silo when the crop is at the right stage.
5. Makes ensilage with greater feeding value.
6. Provides more uniformity of feeding value from any part of the silo.
7. Provides more uniform and solid pack without air pockets, thus preventing molds.
8. Causes no wilting of leaves or loss of precious moisture.
9. Leaves no mud on butts or contaminating soil bacteria.
10. Avoids soggy material such as occurs when the silo is filled too early with green and immature corn.

522. The Harvesting Unit.—The power-driven harvesting unit is similar to that of a row binder. In general, it consists of divider boards,

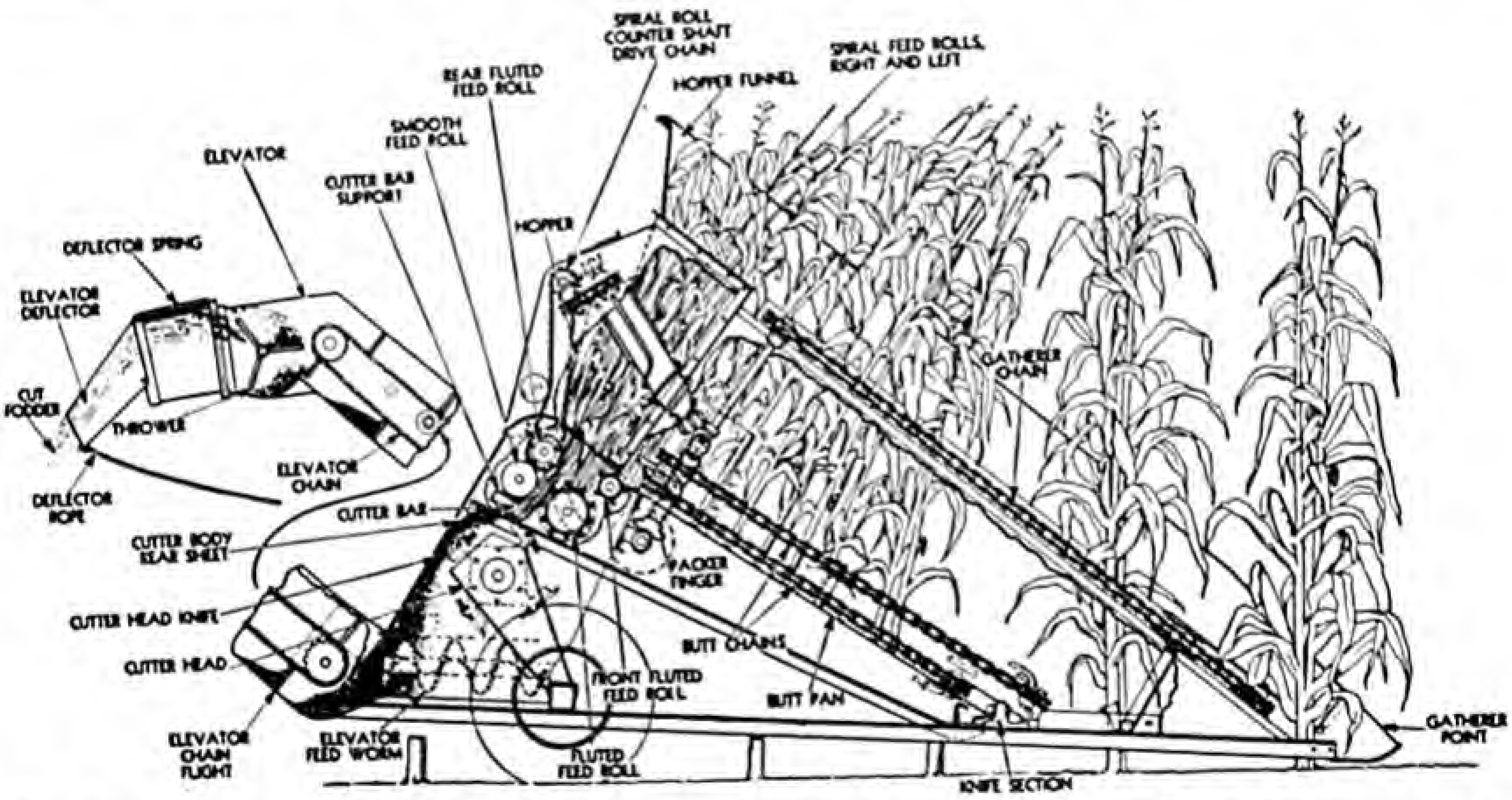


Fig. 633.—Sectional view of field silage cutter showing details of both the harvester and cutter units.

gatherer chains, the side knives, and a single sickle section (Fig. 633). A feeding mechanism of spiral and fluted rolls feeds the stalks butt first into the cutting unit.

523. The Cutting Unit.—Two types of cutterhead are used to chop the stalks into silage lengths. They are *cylinder* and *flywheel*. Figure 635 shows a typical cylinder-type cutterhead. As the chopped silage falls from the cutterhead it is fed into an elevator, which conveys or blows it into a truck or trailer.

The flywheel-type cutterhead is similar in construction and operation to the flywheel cutterhead used on stationary silage cutters (Fig. 634). Knives on the side of the wheel cut the stalks, and the blades on the rim of the wheel throw and blow the chopped silage into a truck or trailer.

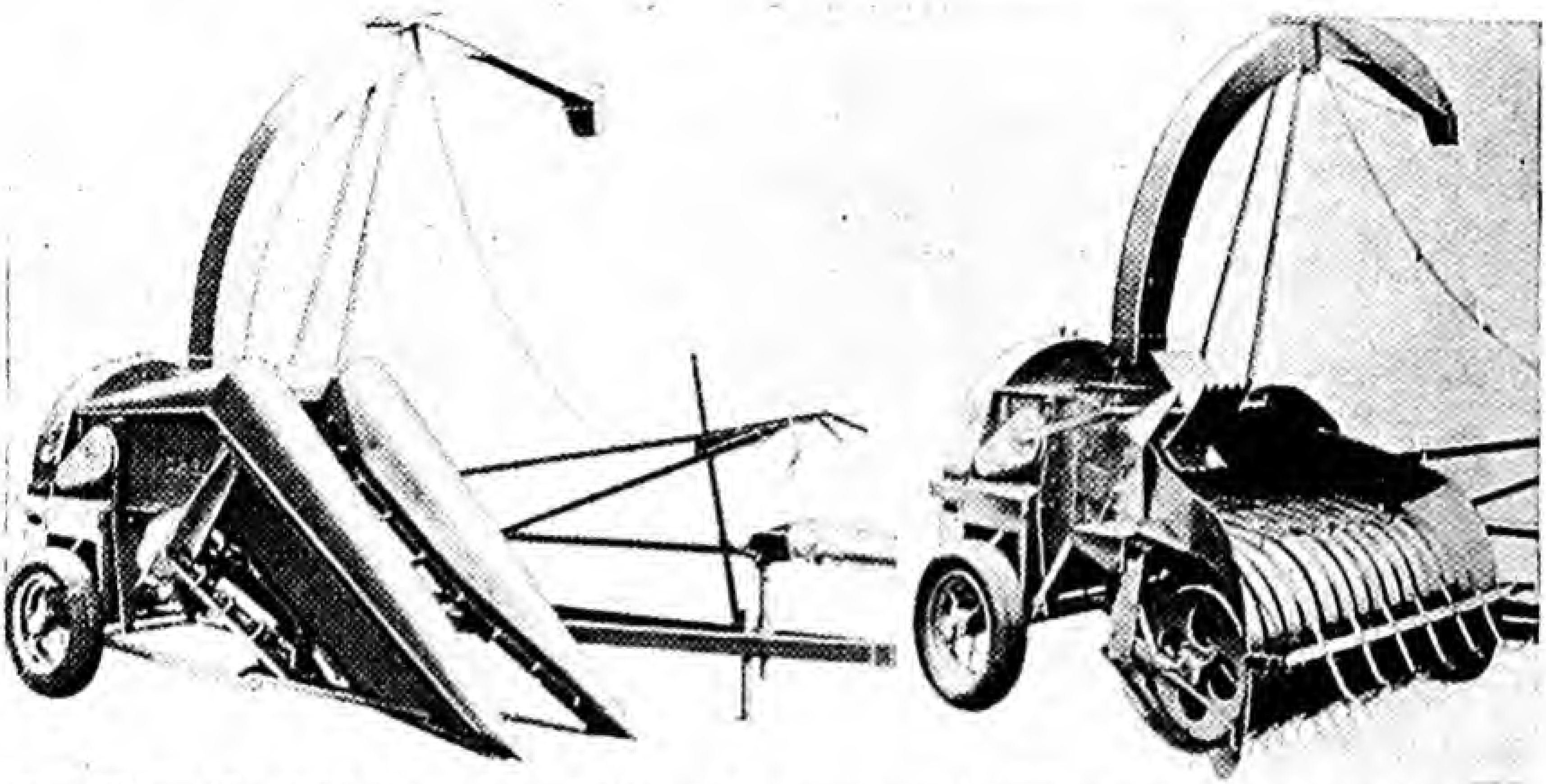


Fig. 634.—The field silage cutter, *left*, can be converted into a hay or grass pickup field grass silage cutter, *right*.

The truck is usually driven along beside the silage cutter. The trailer wagon is drawn behind the harvester. Figure 635 shows a cylinder-type cutterhead.

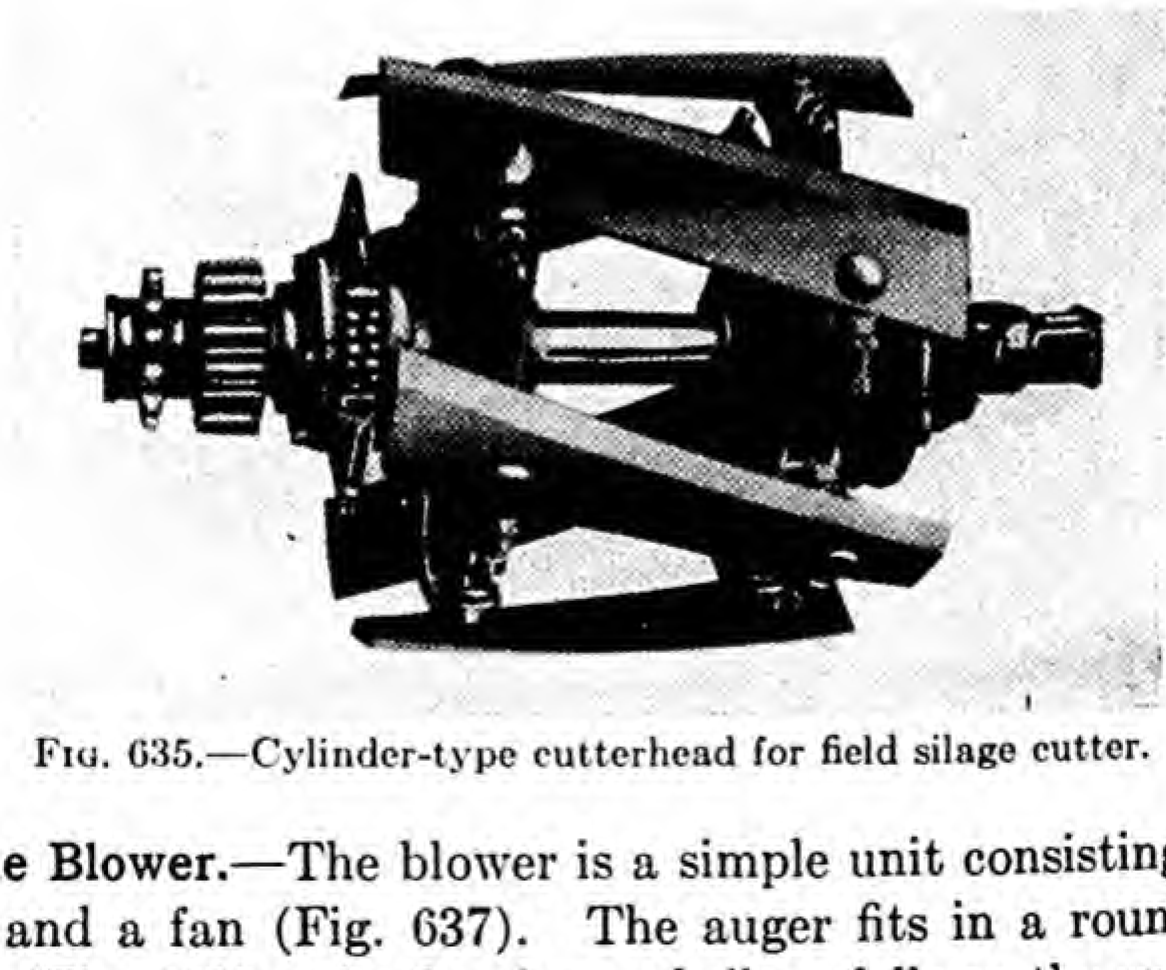


Fig. 635.—Cylinder-type cutterhead for field silage cutter.

524. The Blower.—The blower is a simple unit consisting only of an auger feed and a fan (Fig. 637). The auger fits in a round-bottomed feed hopper (Fig. 638). As the chopped silage falls on the auger, it is fed into the blower fan, which blows it into the silo. A large truckload of silage can be unloaded and blown into the silo in 4 or 5 minutes (Fig. 639).

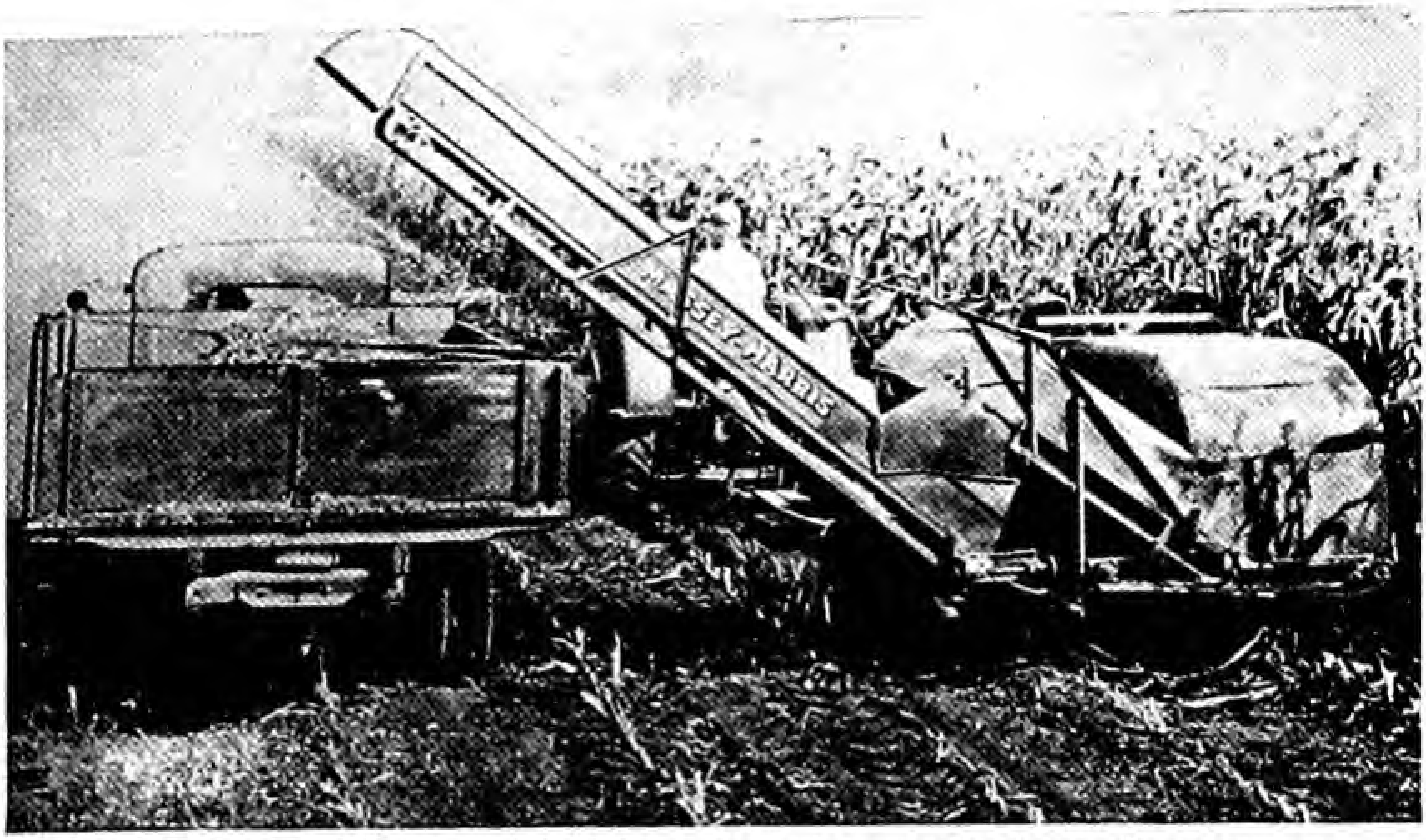


FIG. 636.—Rear view of field silage cutter in operation harvesting corn.

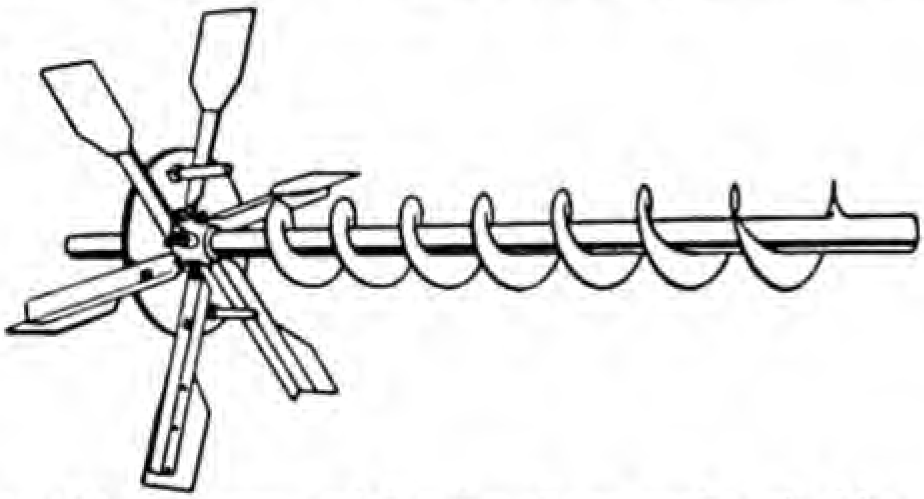


FIG. 637.—Auger and fan for silage and grain blower.

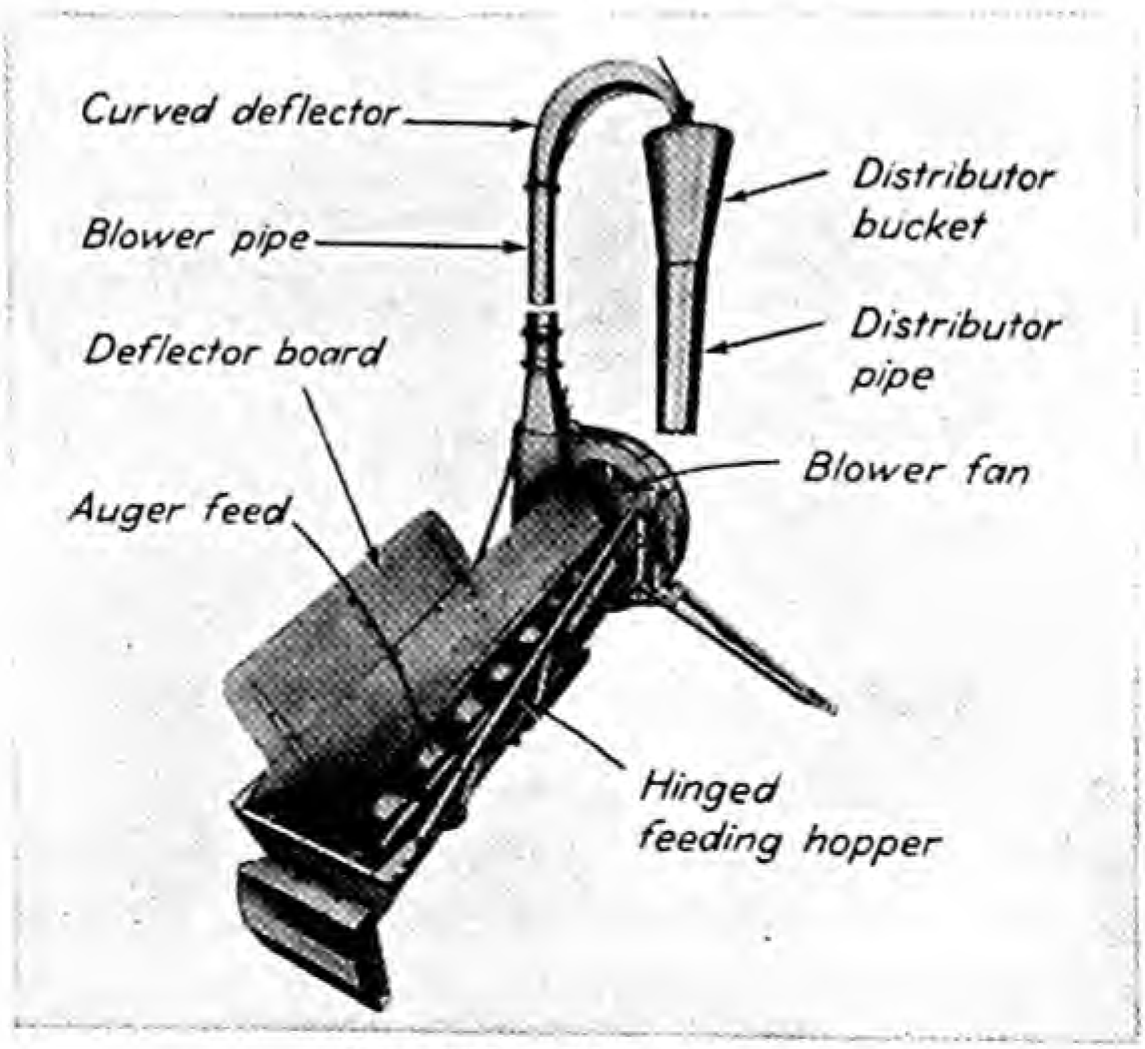


FIG. 638.—Silage blower.

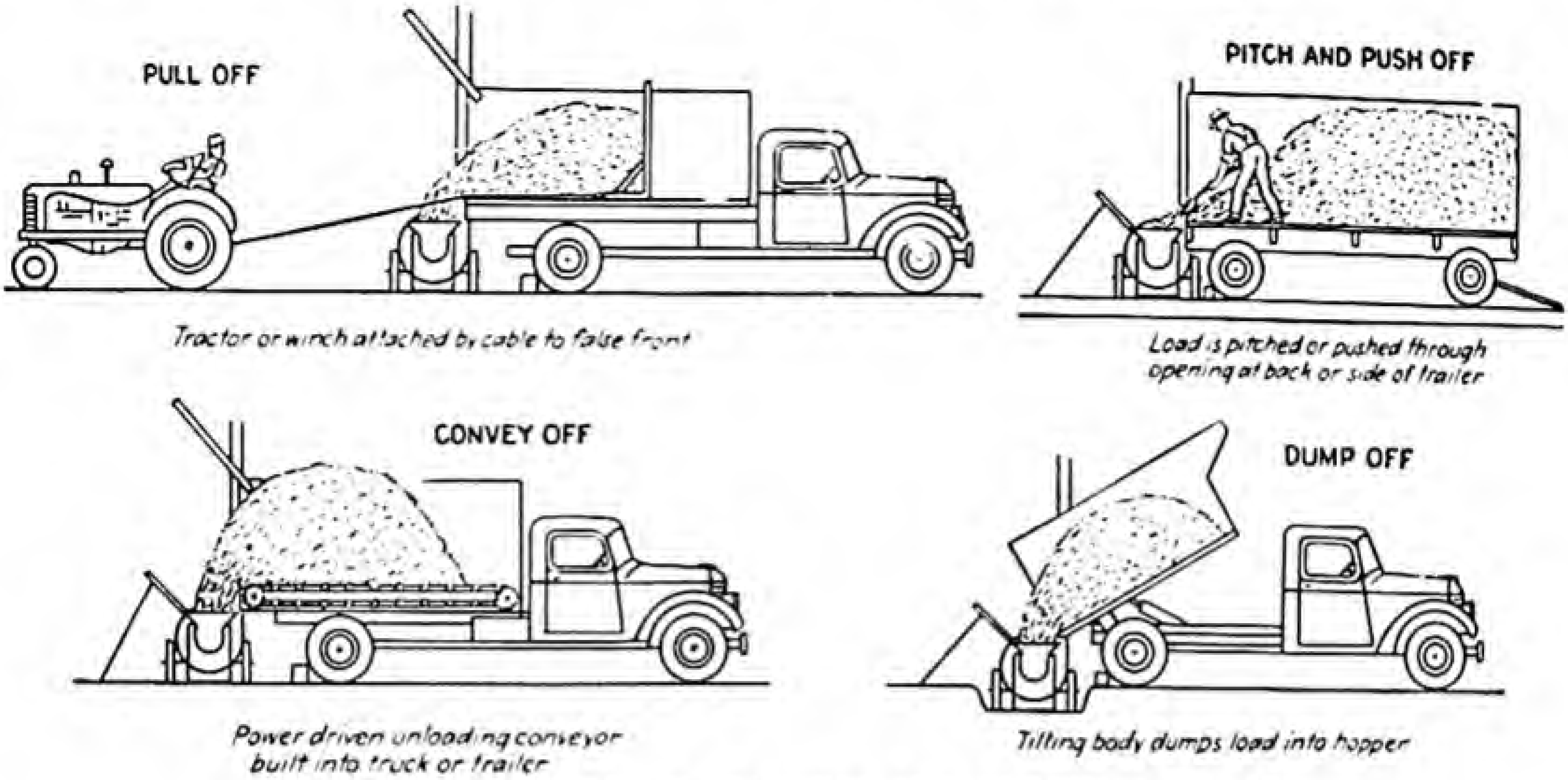


FIG. 639.—Four ways of unloading chopped silage into blower.

FIELD FORAGE HARVESTERS

This type of harvester is designed to mow and chop or to pick up and chop windrowed green grass or legumes and cured hay or straw. Figure 640 shows a power-driven machine equipped with a 5-foot cutter bar, reel, conveying and feeding mechanism, and a flywheel cutter-blower.

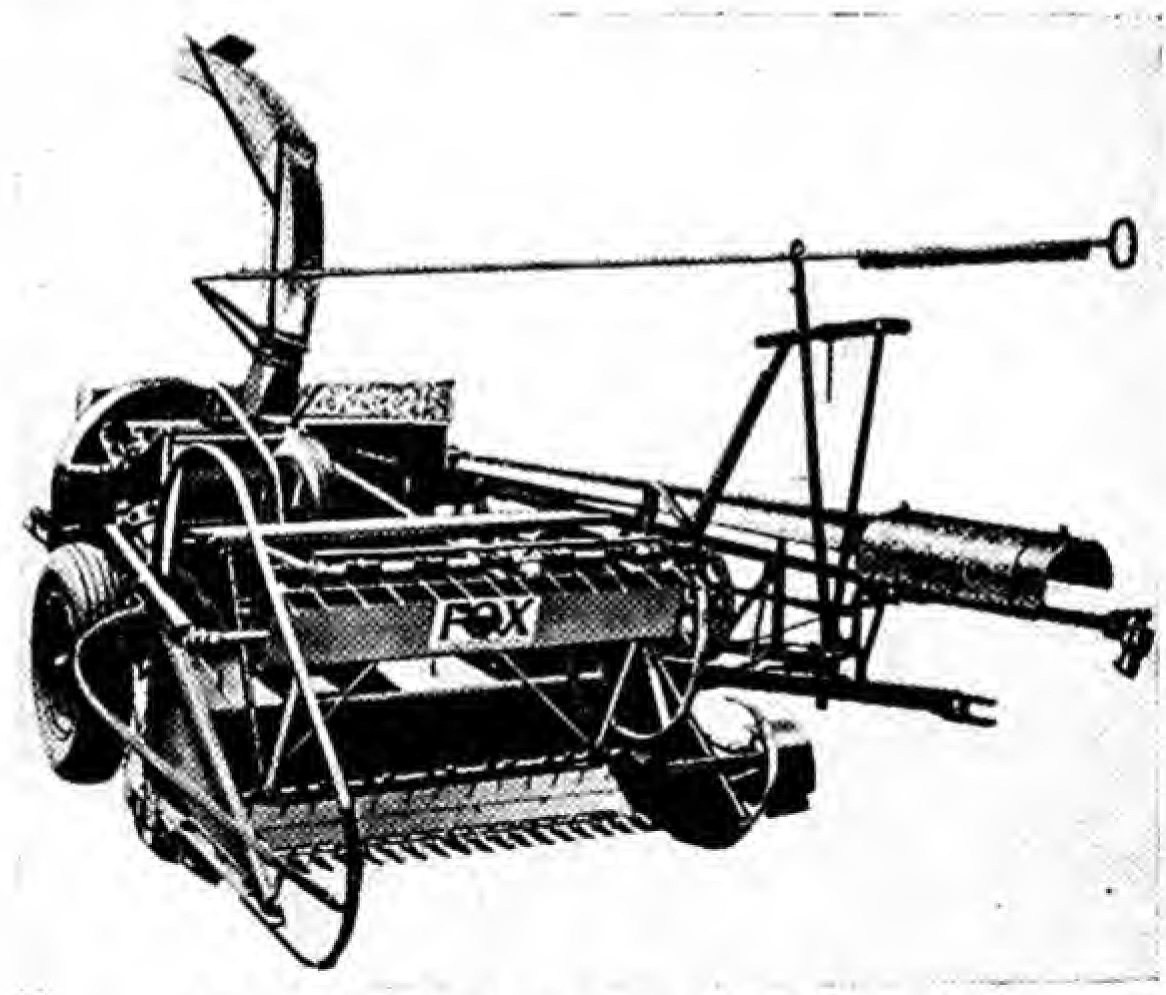


FIG. 640.—Five-foot grass-silage harvester.

Grass or hay can be mowed, chopped, and blown into a truck as one continuous operation. Figure 641 shows two field forage harvesters picking up and chopping hay from the windrow. The machine shown on the left in Fig. 634 can be converted into a pickup field grass or field hay chopper. Most field forage harvesters are power-take-off-driven

and are equipped with an overrunning clutch which permits the cutter-head and blower to clear themselves when the outfit is stopped or slowed down.

FIG. 641.—Two field forage harvesters picking up and chopping hay from the windrow.

When chopping dry cured hay in the field, the truck or trailer must be covered to prevent losses from wind blowing the chopped hay over the sides of the truck.

Where hay is to be artificially dried, field harvesters can be obtained with 6- to 10-foot cutter bars and elevating equipment to deliver the green hay directly from the cutter bar to a truck traveling along beside the harvester.

PART XI

FERTILIZING MACHINERY

CHAPTER XXIX

MANURE SPREADERS

The manure spreader is a machine for carrying barnyard manure to the field, shredding it, and spreading it uniformly over the land.

This type of machine should be on every farm that produces several tons of manure per year. It is a successful machine and is a paying one because it will save labor by spreading the manure faster and more uniformly than can be done by hand.

Manure spreaders may be classified as horse-drawn and tractor types.

HORSE-DRAWN SPREADERS

Horse-drawn manure spreaders are mounted on four wheels and are provided with a tongue and eveners. The construction of the box

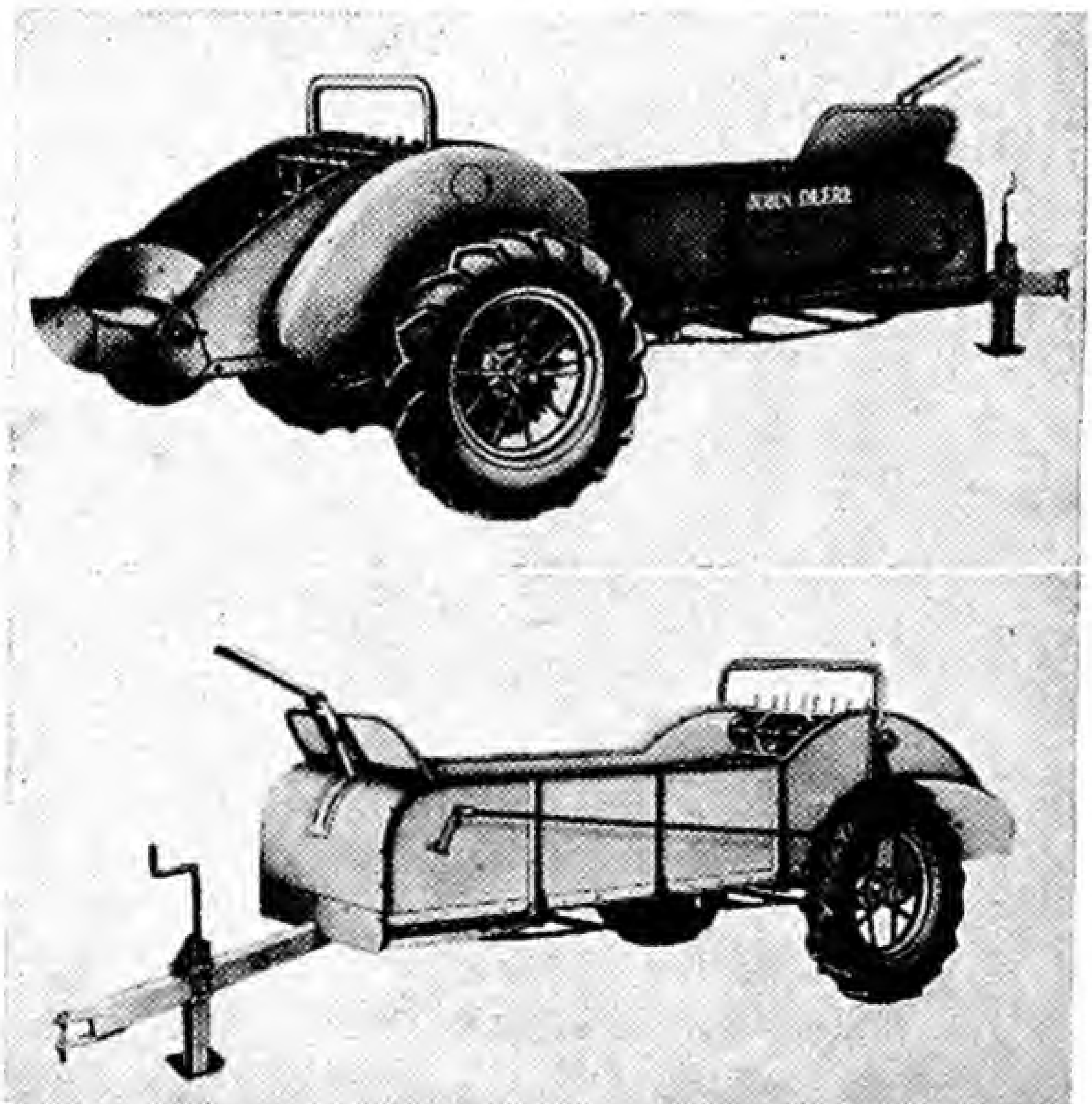


FIG. 642.—Right- and left-side views of tractor-drawn manure spreader equipped with pneumatic rubber tires.

differs from the tractor spreader only in the frame. It is constructed so that front wheels can be attached. The conveyor and the drives for

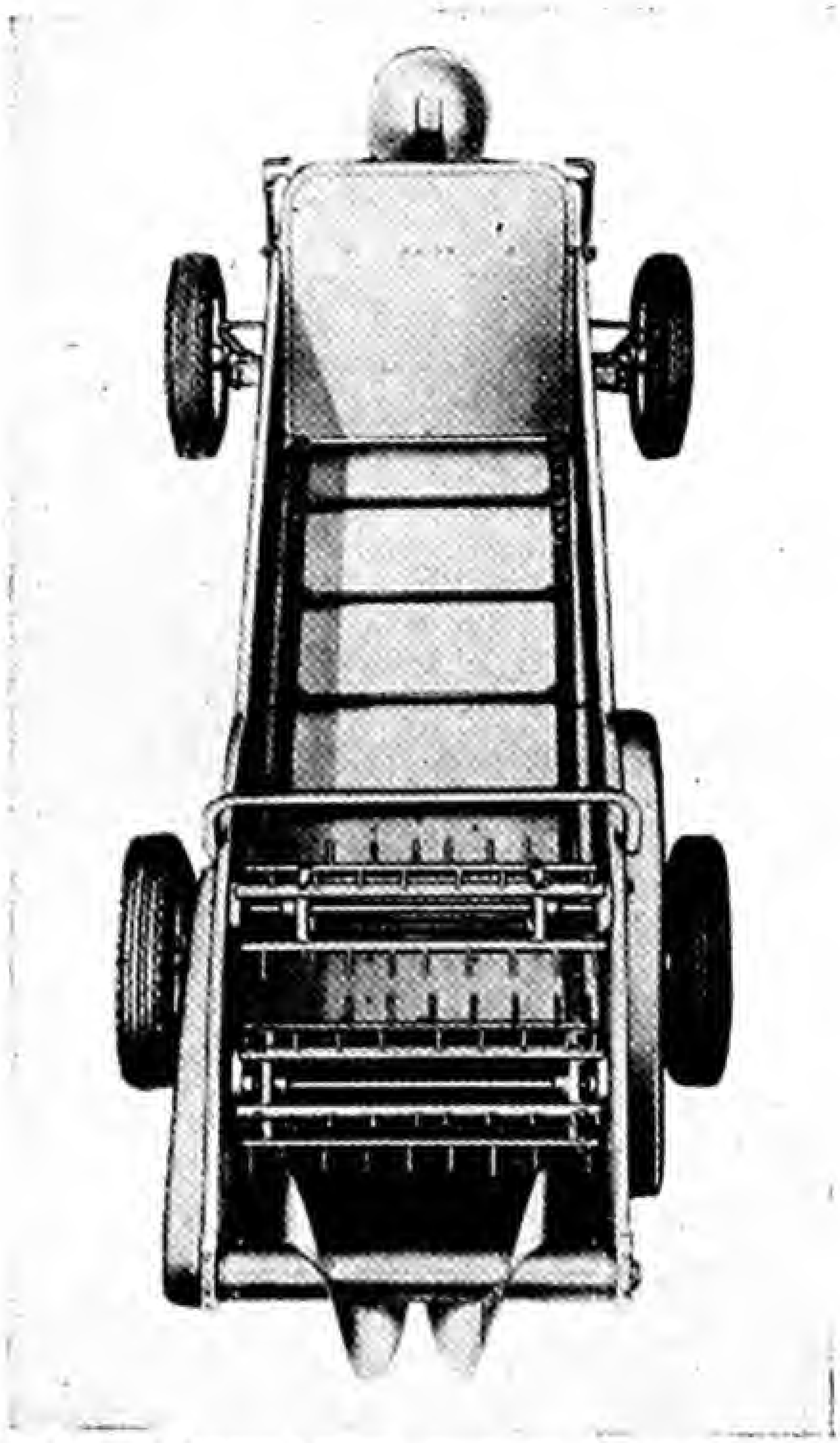


FIG. 643.—Overhead view of horse-drawn manure spreader equipped with pneumatic rubber-tired wheels.

the conveyor and the beaters are quite similar. Figure 644 shows a stub tongue, so that a tractor can be hitched to a horse-type manure spreader.

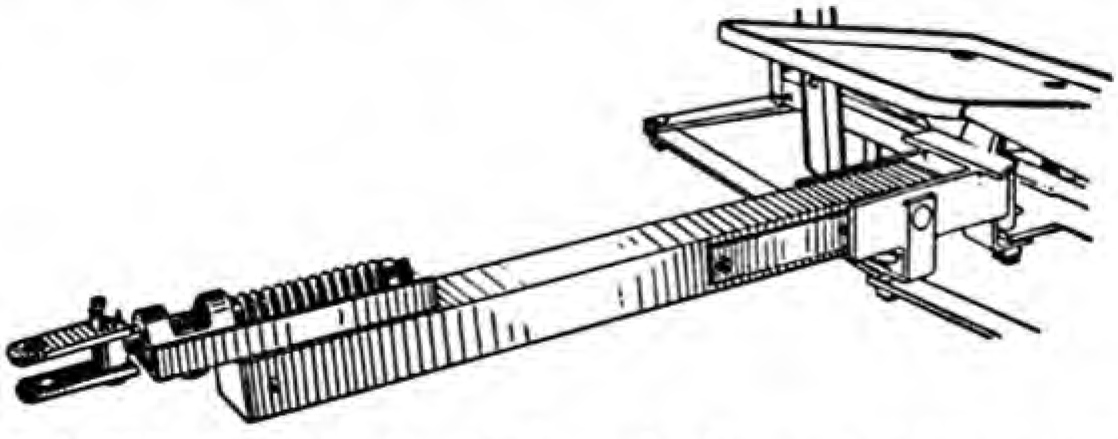


FIG. 644.—A stub tongue for tractor hitch for horse-drawn manure spreaders.

Brakes are also often provided on horse-drawn manure spreaders (Fig. 645).

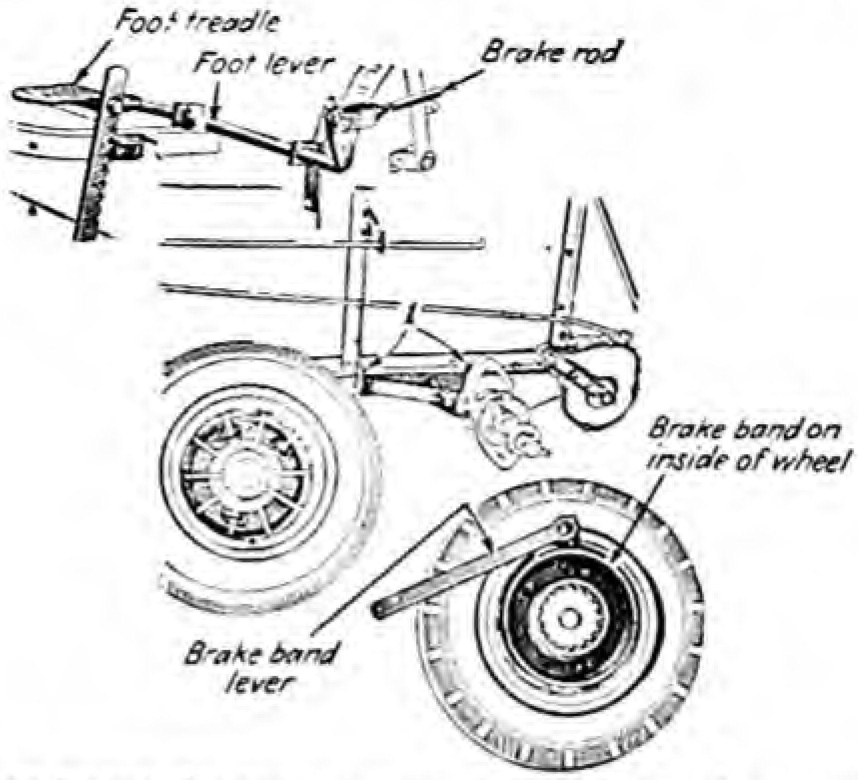


FIG. 645.—Brake for horse-drawn manure spreader can be operated by foot lever.

TRACTOR SPREADERS

As tractors are rapidly replacing horses and mules on farms, manure spreaders have been designed especially for tractor operation (Figs. 646 and 647). The spreader is of trailer construction and mounted on two rubber-tired wheels on an axle located slightly to the rear of the box, so that part of the weight of the spreader will be carried by the tractor. Levers extend forward from the box so they can be easily reached by the tractor operator (Fig. 646). Power for operating the conveyor and beaters is furnished by the wheels of the spreader.

FIG. 646.—A two-wheel tractor-drawn and traction-driven manure spreader equipped with rubber-tired wheels.

525. The Frame.—Since manure is very heavy and at least a ton is loaded on the spreader for each trip to the field, a substantial, yet comparatively light, frame is required. The side rails on all spreaders should be made of a good grade of channel steel properly reinforced and braced. Figure 648 shows a typical frame with the conveyor attached.

526. Conveyors or Aprons.—The quantity and the uniformity of spreading depend to a great extent upon the proper operation of the conveyor or *apron*. It carries the manure back to the rear of the machine, sliding it over the bottom, where it comes in contact with the beaters.

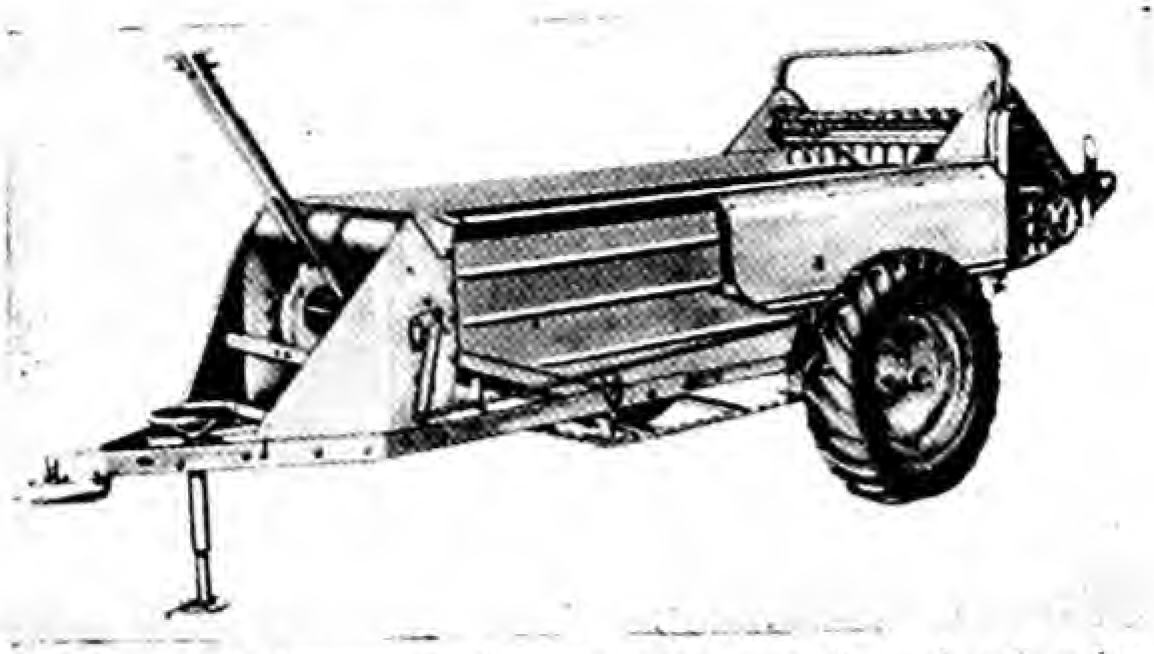


FIG. 647.—A two-wheel tractor-trailer manure spreader, showing levers convenient to tractor operator and lifting jack to support the front of the spreader when not attached to the tractor.

527. The Tight Bottom with Conveyor.—This type of conveyor, which is now practically standard on spreaders, consists of a stationary solid bottom, over which slides an endless web chain of steel slats. Figure 648 shows the conveyor chain in position on the tight bottom of the box. The manure is thrown into the box on the conveyor, which is

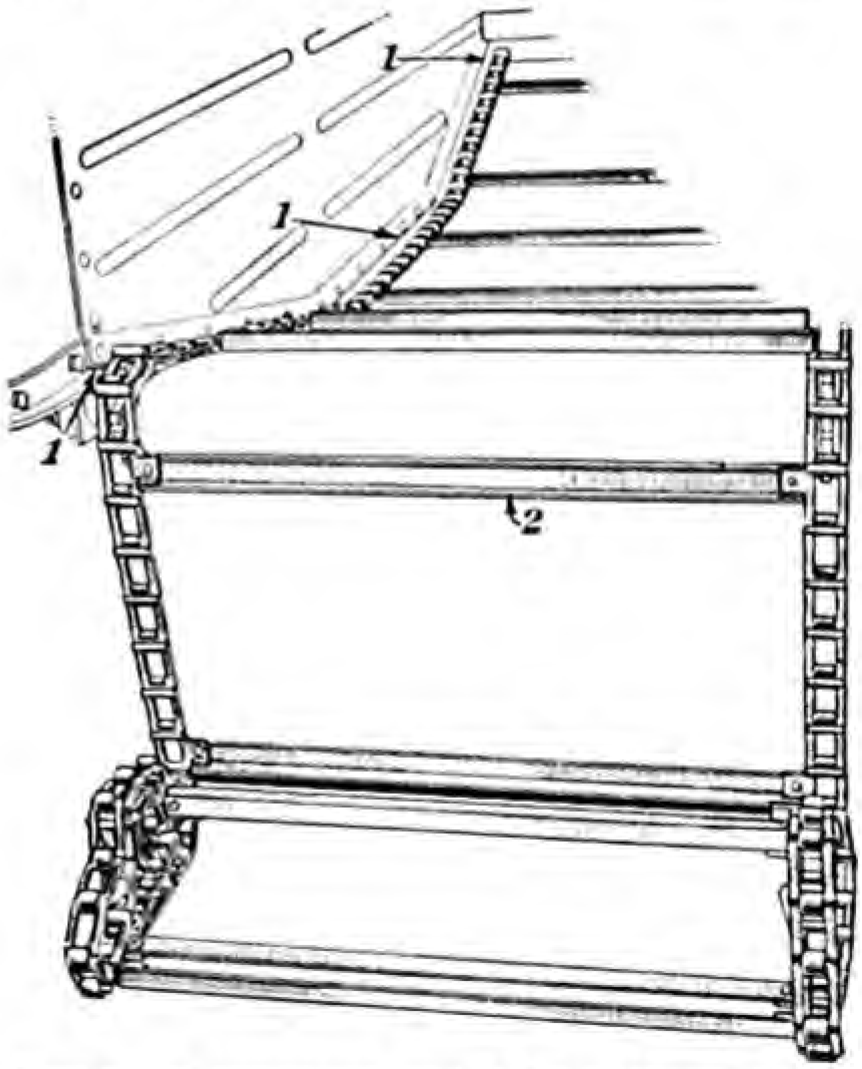


FIG. 648.—Section of conveyor and tight bottom for liquid manure.

stretched over the bottom of the box. Then, as the conveyor moves to the rear, it slides and carries the manure with it.

The conveyor operates very slowly. The minimum travel per revolution of the main drive wheel is about 1 inch, while the maximum is about 3 inches.

The rate of travel is controlled by a lever placed convenient for the driver. From five to twenty loads can be spread per acre.

The tension of the conveyor chain can be adjusted by a setscrew arrangement on each end of the front conveyor shaft.

528. Conveyor Drive.—A ratchet and pawl arrangement is the standard device for driving the conveyor chain of a manure spreader (Fig. 649). As the feed cam raises the rocker arm, it causes the feed pawl to engage the teeth on the ratchet wheel and turn it. The number of teeth engaged by the feed pawl at a stroke is regulated by a stop pawl. This in turn regulates the speed of the conveyor and the volume of manure distributed.

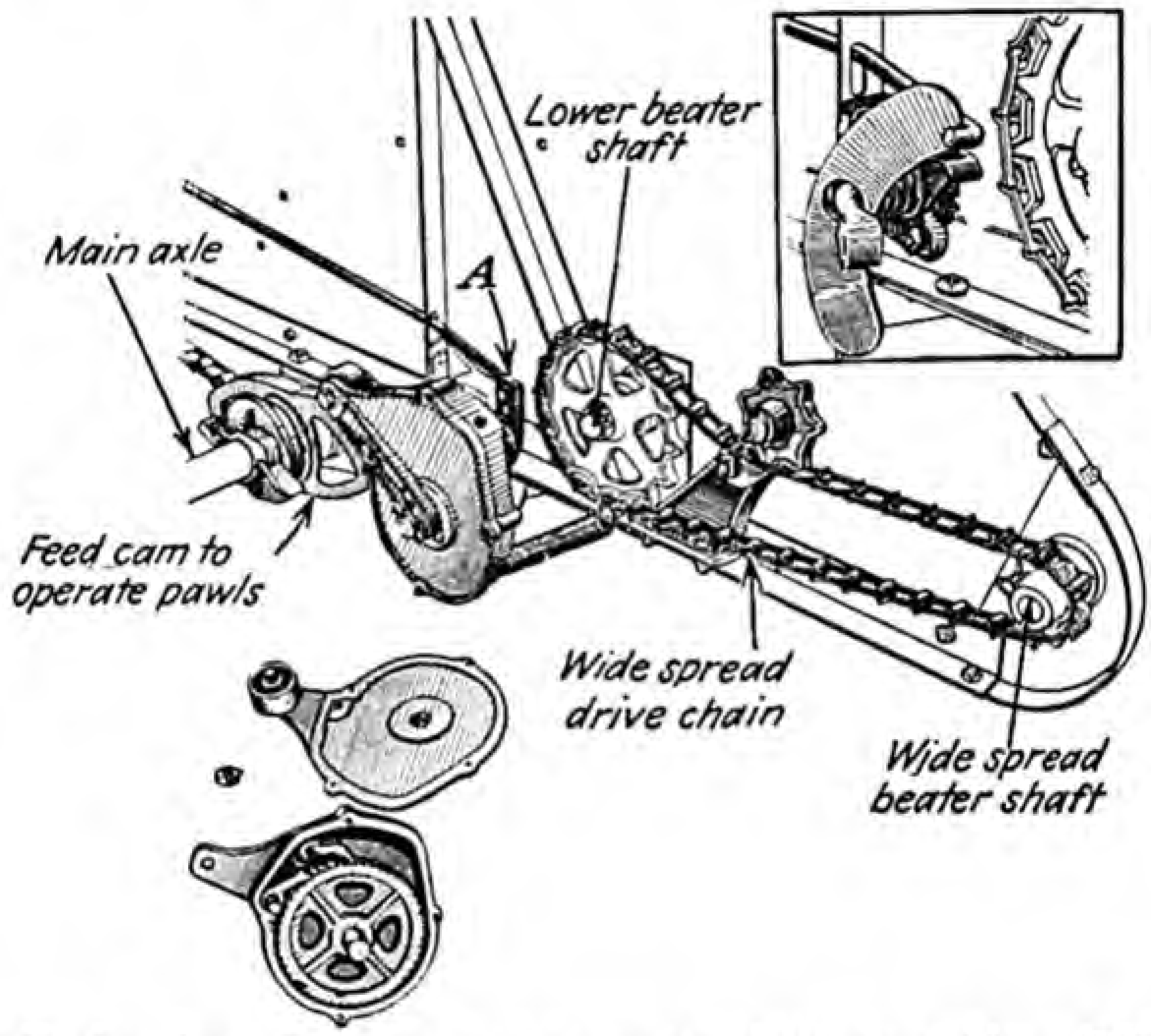


FIG. 649.—Enclosed ratchet apron or conveyor drive assembly. *Below*, the ratchet case is open to show ratchet and pawls. Upper right inset shows bracket for pawls and pawl springs which fit between ratchet case and spreader box at *A*. The lower beater is driven from opposite side of spreader (see Fig. 650).

The adjustment of the feed pawl is controlled by a lever placed convenient for the driver. The lever is connected to the feed pawl by a long rod and can be shifted to any position without stopping the machine.

529. The Lower Beater.—The lower beater is placed just to the rear of the conveyor to beat, tear up, and spread the manure from the rear of the spreader (Fig. 643). It must be substantial because it must spread all kinds of manure in various states of physical condition. It should have good substantial bearings of the self-aligning or roller type. The beater has steel bars through which the teeth are fastened. Some teeth are riveted in, while others are held in place by nuts.

The beater revolves in the opposite direction to the main wheels. It is, therefore, necessary to have some arrangement to give it this reverse motion, which will be discussed under Beater Drive. The beater

should revolve at a comparatively high rate of speed; the ratio is usually about 6 or 7 to 1, that is, a beater revolves about seven times to the main wheel's once.

530. The Upper Beater.—Most manure spreaders have an upper beater placed above and a little to the front of the main beater (Fig. 643). This beater aids the lower beater in tearing up and pulverizing the large flakes that are encountered.

531. Widespread Device.—To prevent the manure being spread too thickly directly behind the center of the machine, a widespread device is used (Fig. 643). This also spreads the manure wider than the machine and makes it unnecessary to lap the loads. The device consists of spiral steel blades. One-half the spiral is set to throw to the left, while the other half is set to throw to the right.

The manure is thrown backward by the beaters against the revolving spirals, which throw it backward and outward and spread it uniformly over a width of 7 or 8 feet. The widespread beater is driven by a chain from the main or auxiliary beater shafts.

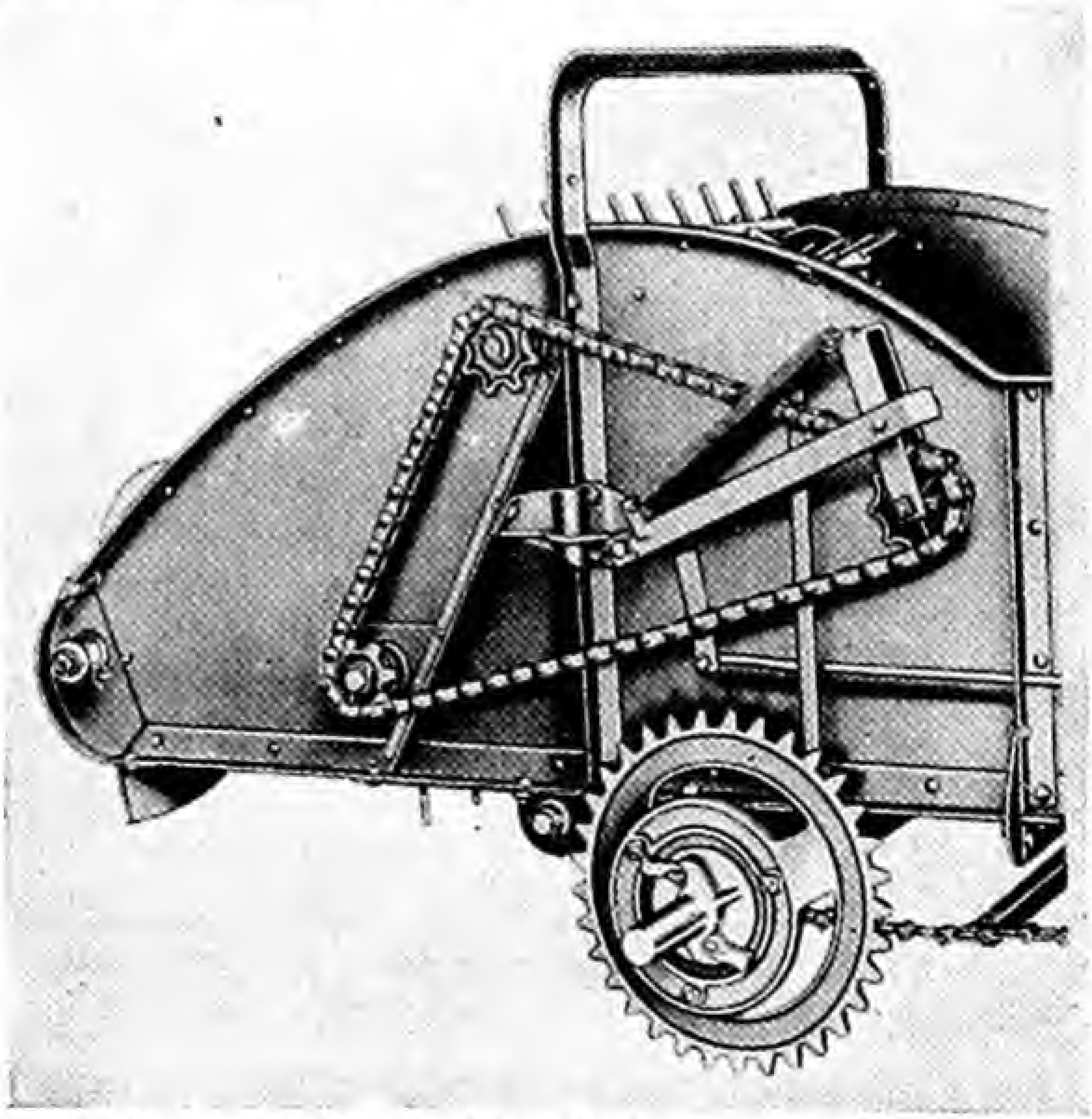
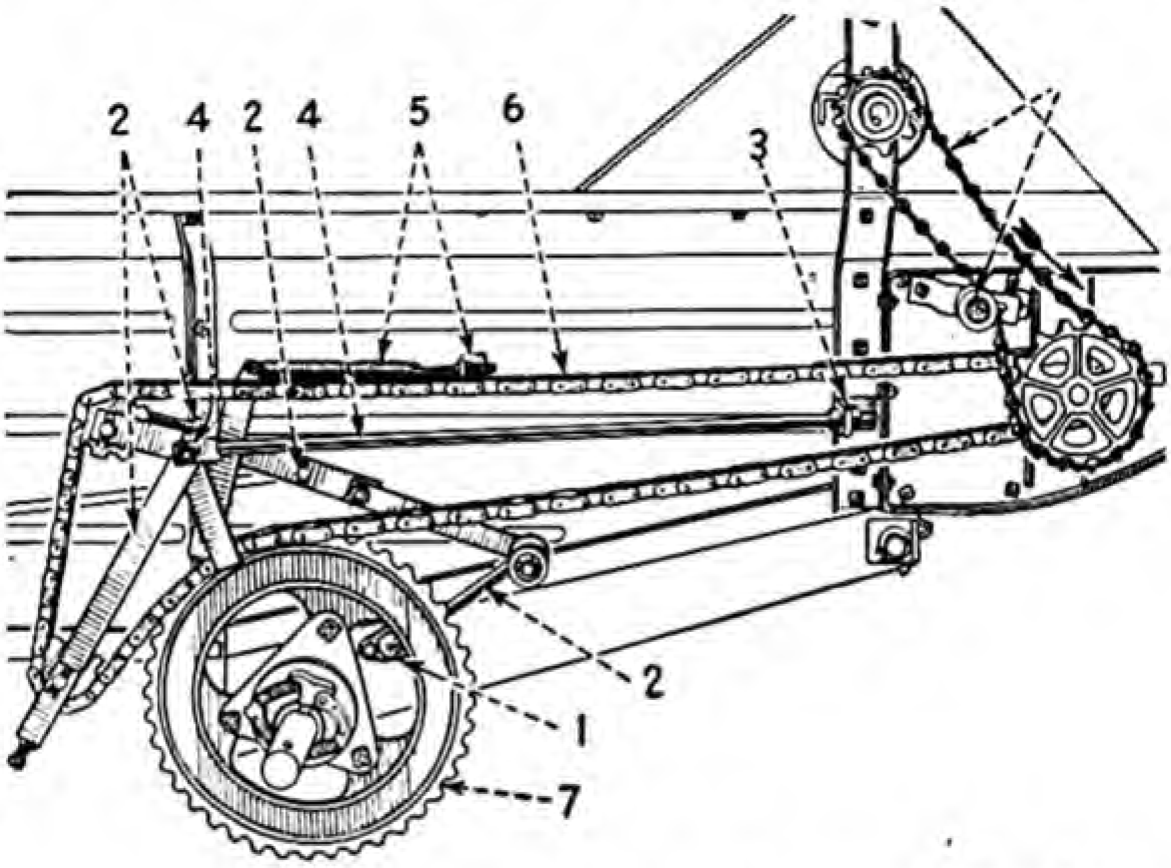


FIG. 650.—Lower and upper beaters are driven by large sprocket on main axle when chain is lowered enough to contact the top arc of the sprocket.

532. Beater Drive.—The chain is the common method of driving the beaters on manure spreaders. A large drive sprocket is mounted rigidly on the main axle. In Fig. 650 the drive chain passes around a sprocket on the end of the upper beater shaft and main beater shaft, and around a

movable idler sprocket. The chain does not pass around the drive sprocket. As the movable idler sprocket is lowered, the bottom part of the drive chain is lowered onto the drive sprocket. This will cause the beaters and widespread device to turn in the opposite direction to that of the main drive sprocket. The machine is thrown out of gear by raising the drive chain from the drive sprocket (Fig. 651). This is done



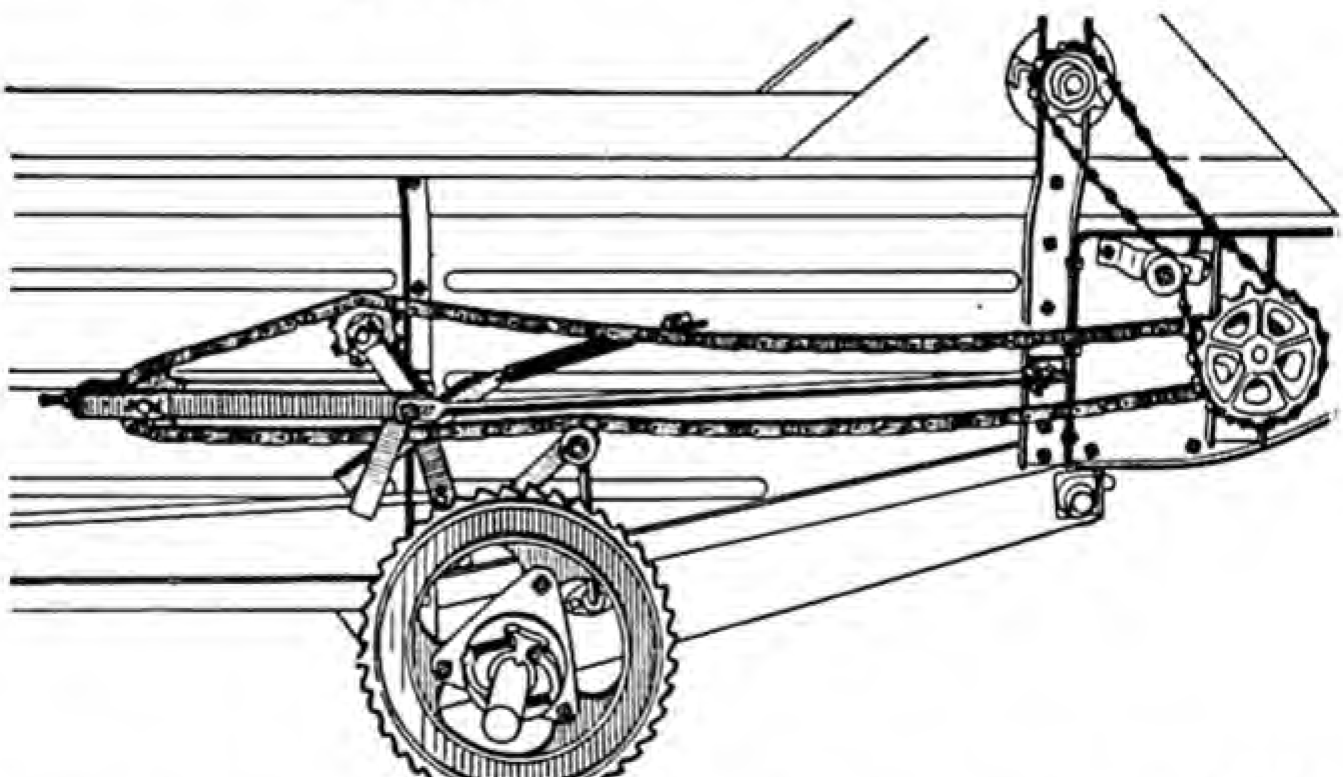


FIG. 651.—Power for the beaters is transmitted to the lower beater shaft by a chain in contact with the top of a sprocket on the main axle, *top*. The bottom view shows the chain in raised position, "out of gear."

by a control lever placed on the front of the box and connected to the idler sprocket by a rod.

533. Box.—An interior view of the box is shown in Fig. 643. The box of the standard spreader has a tight wood bottom with side boards to hold the manure. The box should be about 1 to 1½ inches wider at the rear than at the front so the manure will not wedge between the side boards as the conveyor carries it to the rear of the machine. Liquid or

semiliquid manure is spread by mixing with more solid or drier manure. Manure spreader boxes are being made with liquidtight sump bottoms (Fig. 652). An outlet drain is also shown in Fig. 652.

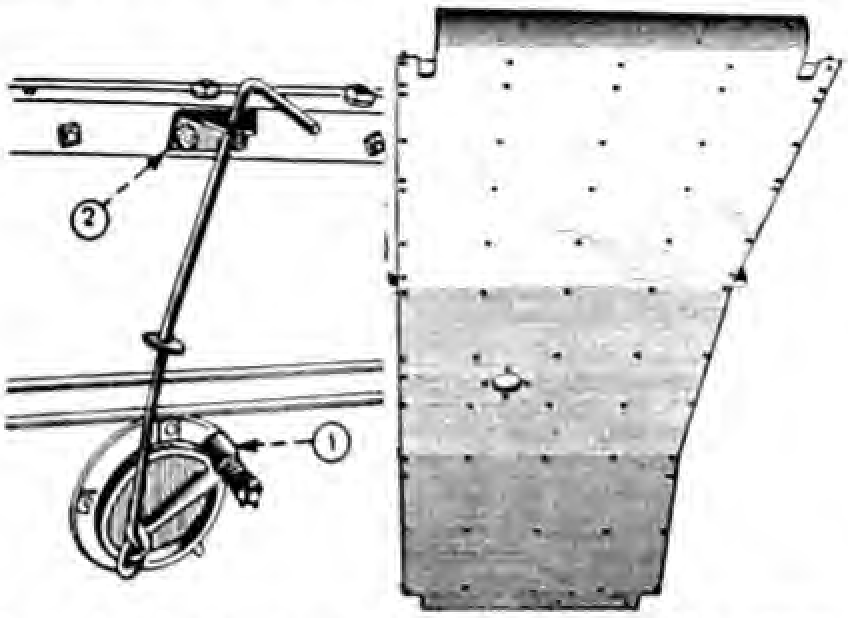


Fig. 652.—Outlet drain in the center of the bottom of the sump of a liquid box permits drainage and cleaning of the box. A valve for the drain outlet is shown at the left of the bottom.

The front end gate is inclined forward so the manure can be heaped up. As the load moves backward, the manure will fall forward and level out.

A rear end gate, as shown in Fig. 653, prevents the manure packing

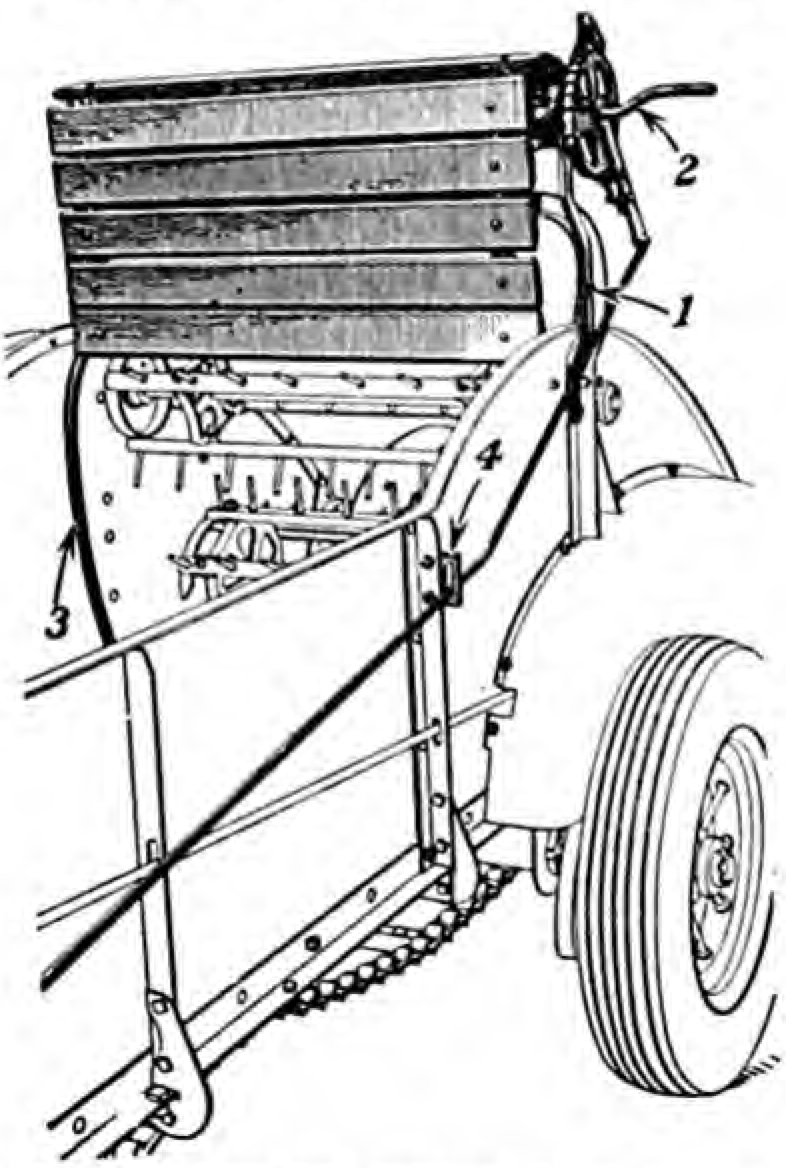


Fig. 653.—End-gate attachment prevents manure from packing against beaters, which may make starting hard.

against the beaters while on the way to the field. It makes the beaters easier to start. Soft wet manure will not leak out at the rear when an end gate is used.

534. Size and Capacity.—The size of a manure spreader is usually given in bushels. The average spreader will hold from 60 to 70 bushels. A dry-measure bushel is equal to 2,150.4 cubic inches.

535. Lime-spreader Attachment.—Figures 654 and 655 show attachments for manure spreaders to spread lime.

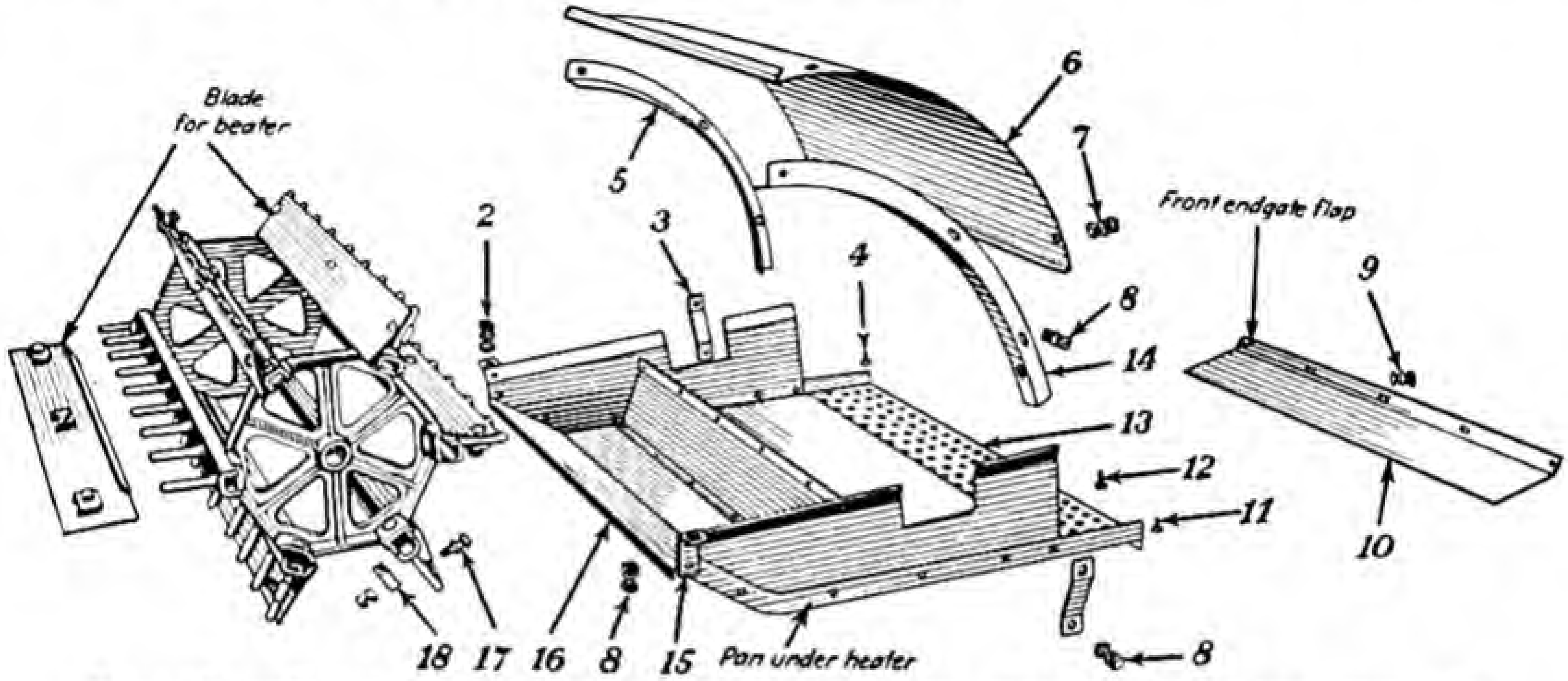


FIG. 654.—Parts for converting a regular manure spreader into a lime spreader.

536. Loading the Spreader.—It is considered the better plan to start loading at the front end and finish at the rear end. The manure is torn up and broken to pieces easier when the load is put on in this manner.

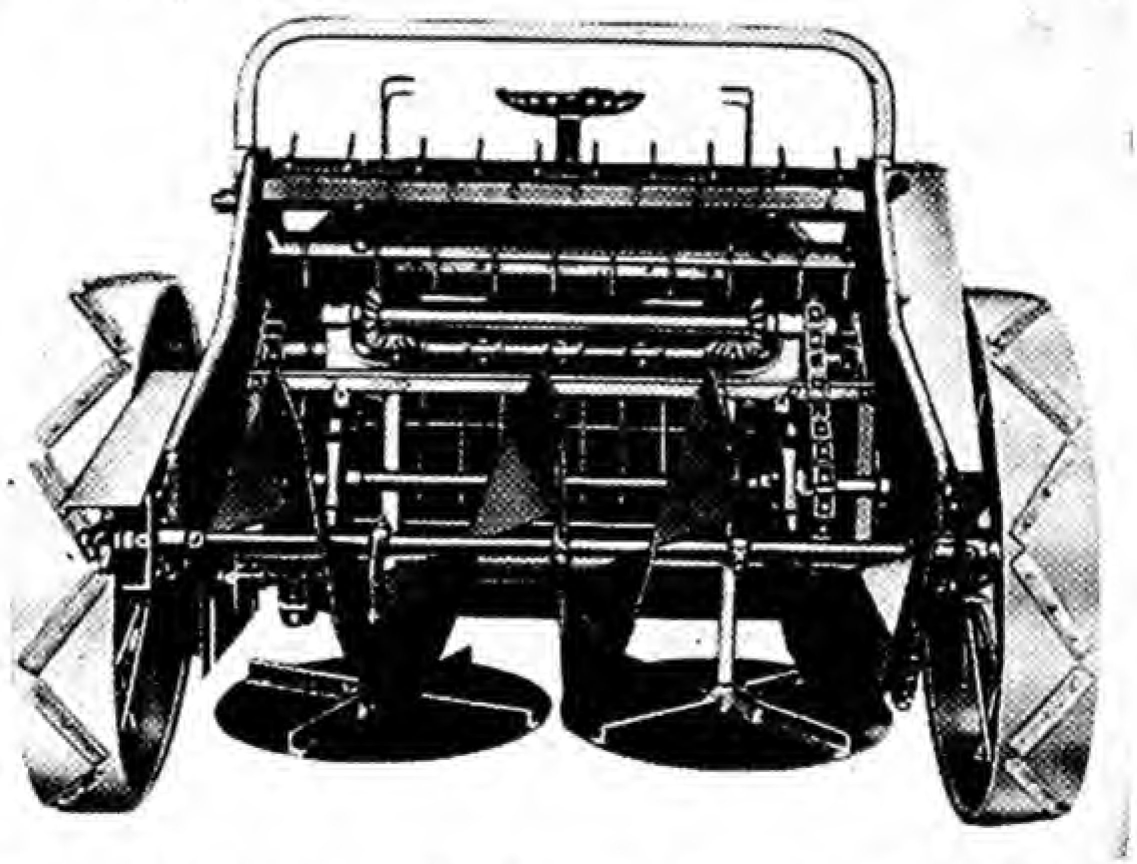


FIG. 655.—Lime-spreader attachment for manure spreaders consisting of two revolving flat discs.

537. Mechanical Loaders.—When spreading manure with a manure spreader, more time is consumed in loading than in any other operation. This is also the hardest work. Mechanical loaders are available, which load the manure on the spreader so that it is not necessary to do it with a pitchfork (see Chap. XXXIV).

CHAPTER XXX

COMMERCIAL-FERTILIZER DISTRIBUTORS

The use of commercial fertilizers is becoming more extensive each year. Such fertilizers are of many kinds and vary from highly concentrated chemicals, which must be used in small quantities, to a rather low-grade mixture used in large quantities.

A fertilizer distributor is required to distribute varying amounts of fertilizer, in almost any physical and mechanical condition, and place it in the soil so that it will not injure the seed. It is difficult to design a machine that will meet such a wide range of requirements.

538. Location of Fertilizer in Relation to the Seed.—A committee of the American Society of Agronomy on fertilizer application recommended that all fertilizer attachments on planting and seeding machinery be so designed as absolutely to prevent contact between seed and fertilizer.

A joint committee on fertilizer application, representing the American Society of Agronomy, the American Society of Agricultural Engineers, The National Fertilizer Association, and the National Association of Farm Equipment Manufacturers, adopted the following statement on fertilizer application:

> Contact of fertilizer with the seed, except when fertilizer is used in very small amounts, tends to depress and delay germination and may even prevent it. The extent of this delay or depression varies with the materials used in the fertilizer, with the moisture content of the soil, with the crop grown, and with the quantity of fertilizer applied. The recommended fertilizer placement is 2 to 3 inches to the side of the row and 3 to 4 inches below the soil surface. The location of the fertilizer will depend upon the amount and kind of fertilizer and the row spacing.

Accepting the above statements, we find that the fertilizer may be applied as hill applications with hill dropping of the seed, or may be drilled when the seed are drilled. For the small grains, it may be either drilled or broadcasted.

539. Types of Distributors.—There are several different types of fertilizer distributors. Some fertilizer attachments for planters and cultivators were described under Seeding and Cultivating Machinery. The design of the machine is greatly influenced by the time at which the fertilizer is to be placed in the soil. It is the practice in certain sections

to distribute part of the fertilizer before planting and part after the crop is well advanced, as a side dressing. Many small-grain growers like to drill or broadcast the fertilizer before planting. The bulk of the fertilizer for crop production, however, is handled by fertilizer-distributing attachments on planting and seeding machinery. Applications of lime are usually broadcasted. A new development is to place a fertilizer distributor on the plow and apply the fertilizer on the plow sole or in the bottom of the furrow (Fig. 656).

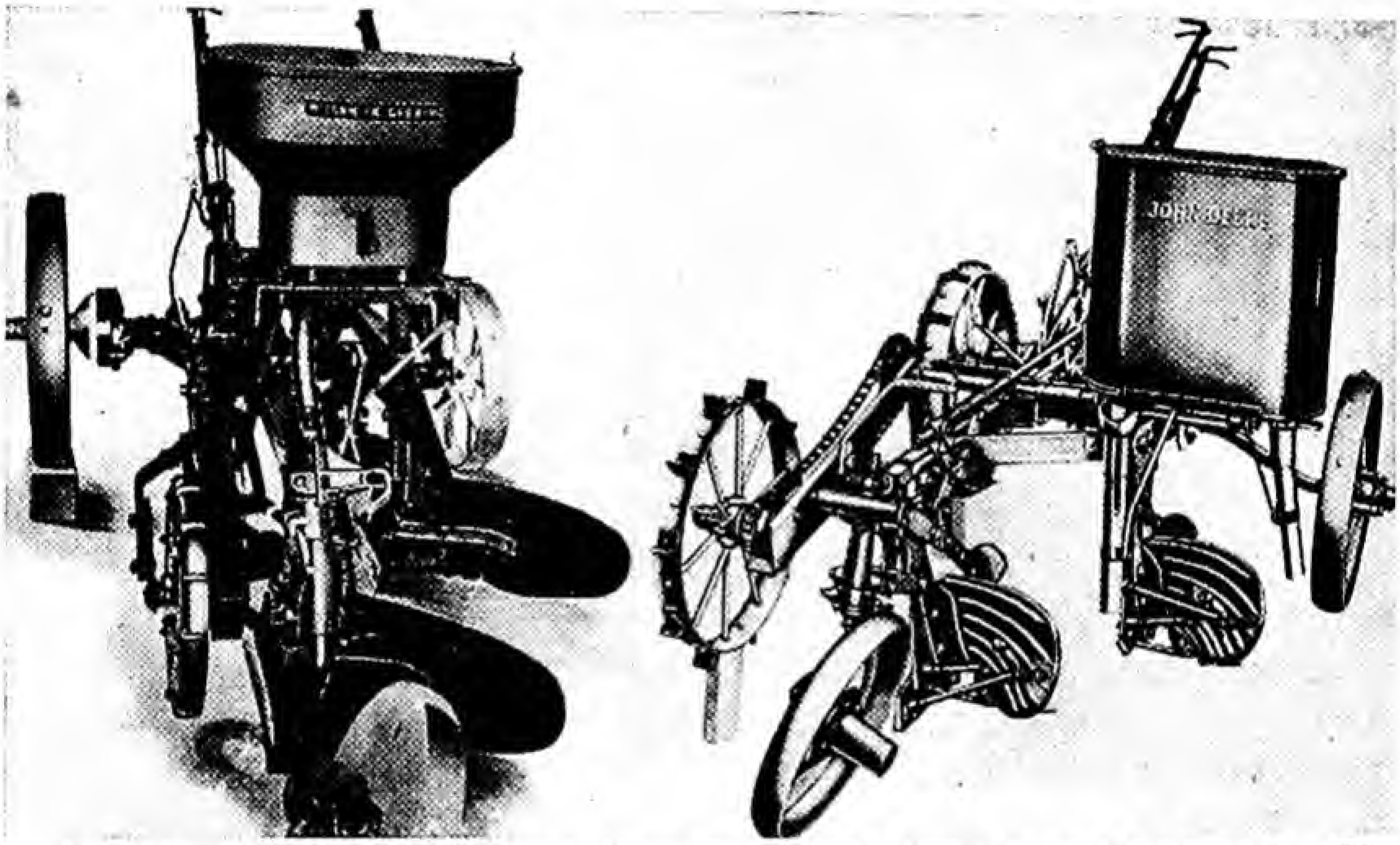


FIG. 656.—Fertilizer attachments for plows to apply fertilizer on the plow sole. The attachment shown at the right places the fertilizer so that it will be covered immediately, while the attachment at the left places one of the bands behind the rear bottom where it is left exposed until the plow passes again.

The types of fertilizer distributors are the walking vibrator; the attachments for one- and two-row planters, grain drills, and cultivators; and the broadcast distributors.

540. Vibrator or Knocker Distributor.—Figure 657 shows a fertilizer distributor used to place the fertilizer in the soil before planting. It consists of a wood hopper, trapezoidally shaped, mounted on a beam, having a steel wheel at the rear and a foot for a furrow opener directly under the hopper. The hopper is hinged on the lower front edge. The rear side of the hopper is supported by an arm extending to the rear and resting on a series of lugs on the side of the drive wheel. At the bottom of the hopper there is a tray with an adjustable control.

The fertilizer is shaken from the hopper by vibrations caused by the knocker coming in contact with the lugs on the side of the revolving wheel.

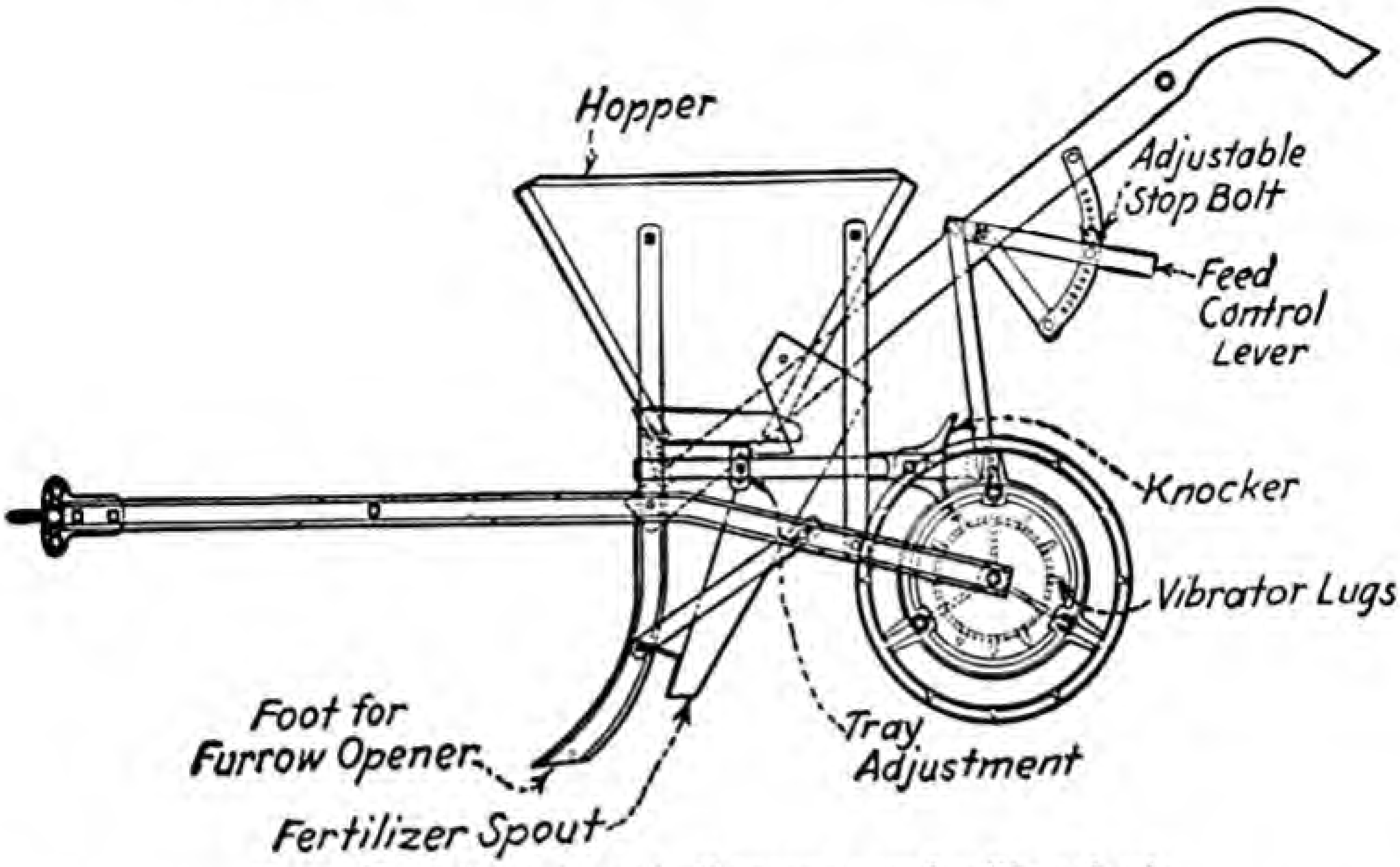


FIG. 657.—Side view of vibrator-type fertilizer feed.

The fertilizer may fall into a single spout and, thence into the row, or into a double spout which will deposit it as a side dressing beside two rows of plants.

FERTILIZER ATTACHMENTS FOR ROW PLANTERS

Fertilizer-distributing attachments can be secured for all types of row planters.

541. For One-row Walking Planters.—One-row walking planters with fertilizer attachments are shown in Figs. 658, and 660. The fertilizer

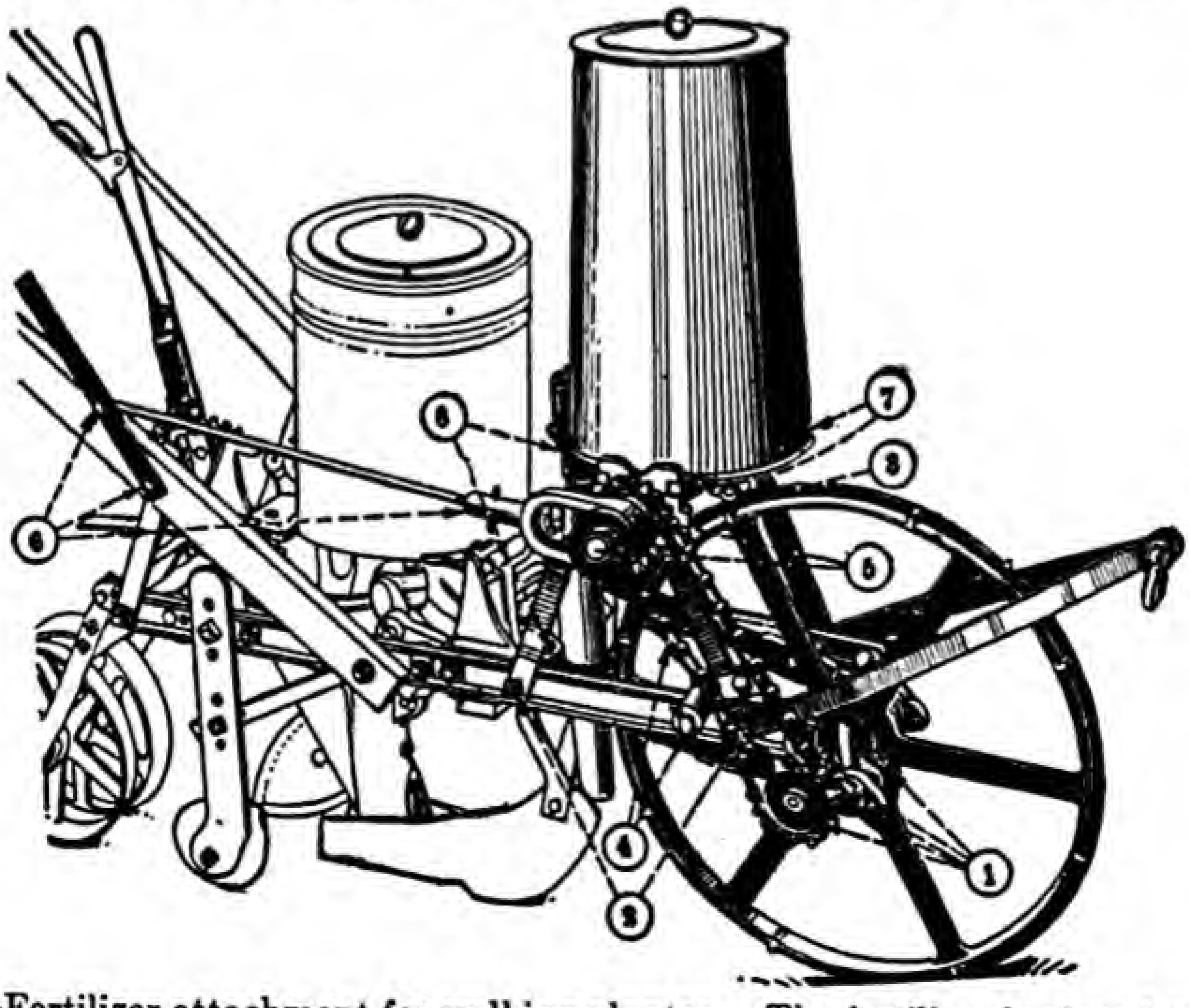


FIG. 658.—Fertilizer attachment for walking planter. The fertilizer is placed to the side of the seed.

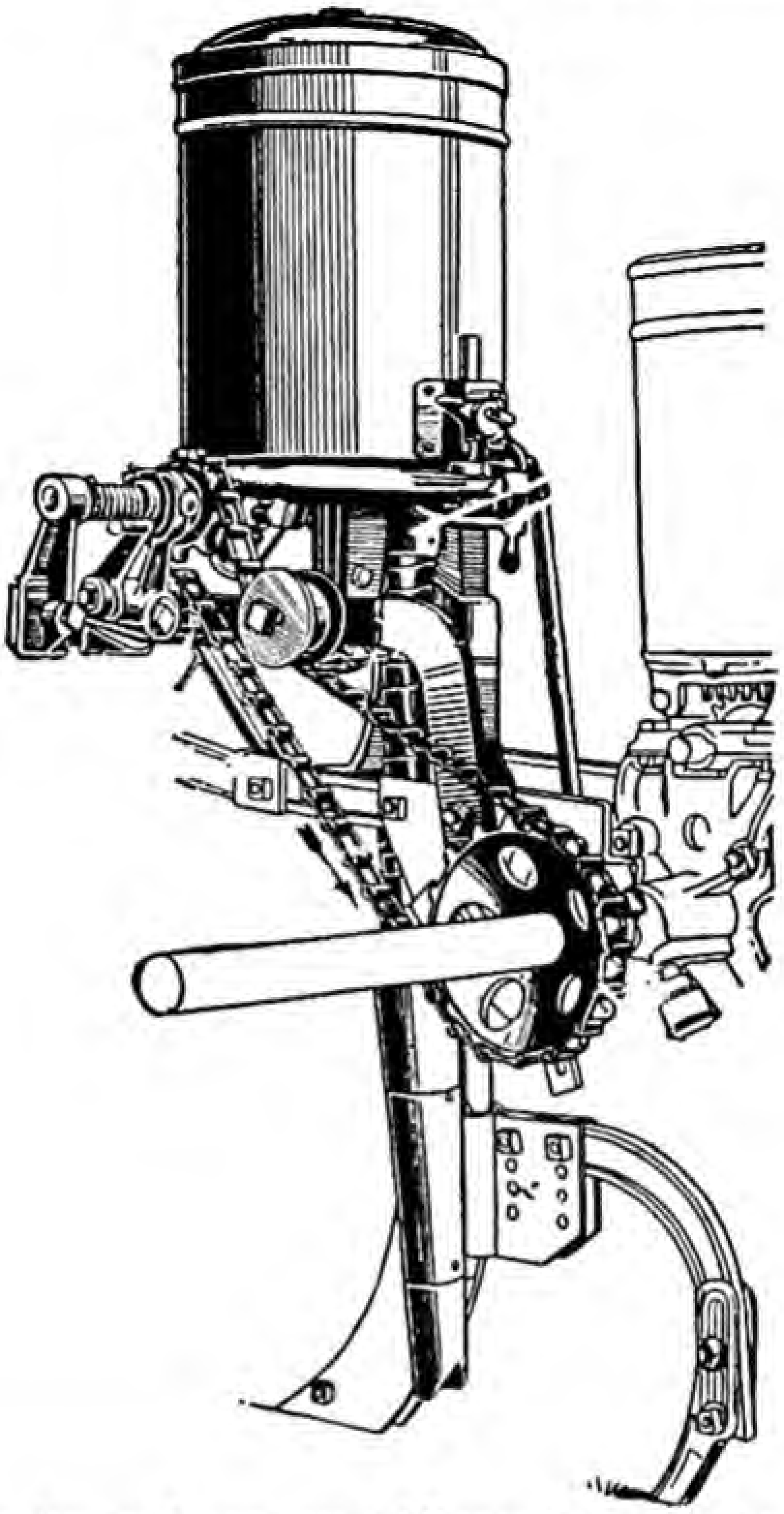


FIG. 659.—Fertilizer attachment for one-row riding cotton and corn planter. The fertilizer is mixed in the row.

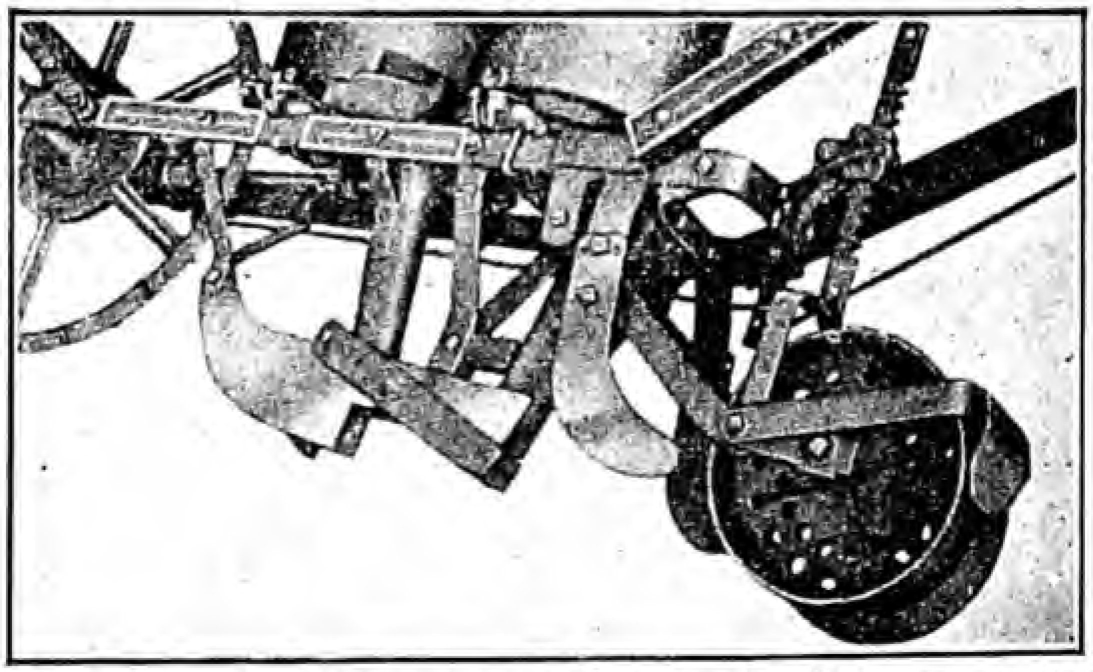


FIG. 660.—Tipover view of walking planter showing fertilizer spout, seed spout, fertilizer covering blades, knife opener, and press wheel with automatic scraper. The fertilizer is placed below the seed.

hopper is placed to the front of the seed hopper. The feeding device is driven by a sprocket and chain from the drive wheel or by the cranks attached to the pitmans that drive the planting mechanism.

The fertilizer (Fig. 659) is deposited in front of the furrow opener and partially mixed in the row above the seed.

In Fig. 660 the fertilizer is placed in a furrow and mixed in the row below the seed.

542. For One- and Two-row Riding Drill Planters.—One- and two-row cotton and corn planters can be equipped with fertilizer attachments, as shown in Figs. 659 and 661. The fertilizer hopper is mounted to the front of and slightly higher than the seed hopper. The fertilizer-distributing mechanism is driven from the main axle by sprocket and chain.

The fertilizer is deposited by the feeding mechanism on the ground behind the sweep or middlebreaker and just ahead of the seed furrow opener (Fig. 659). The furrow-opener shovel plows through the fertilizer, mixing it with the soil in the row.

543. For Check-row Planters.—Where corn is checked it is desirable to place the fertilizer near the hill. The attachment shown in Fig. 662 is designed to drop a quantity of fertilizer automatically at each hill of corn.

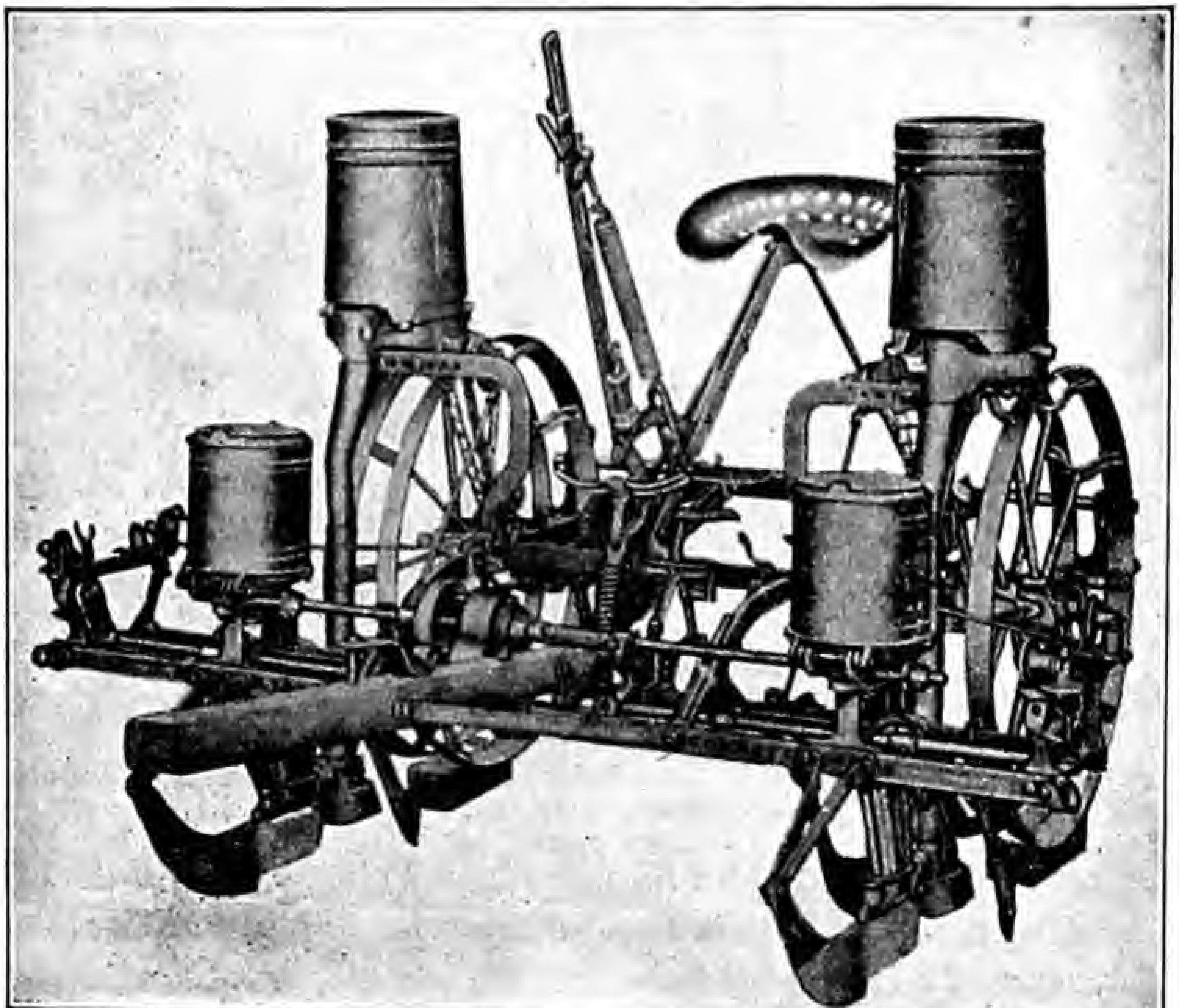


FIG. 661.—Automatic hill-dropping fertilizer attachment. The fertilizer is placed above the hill.

Truog[1] recommends that a fertilizer attachment for a corn planter should be adjustable, so that quantities ranging from 75 to 200 pounds per acre may be applied in the hill. This fertilizer should be applied in a

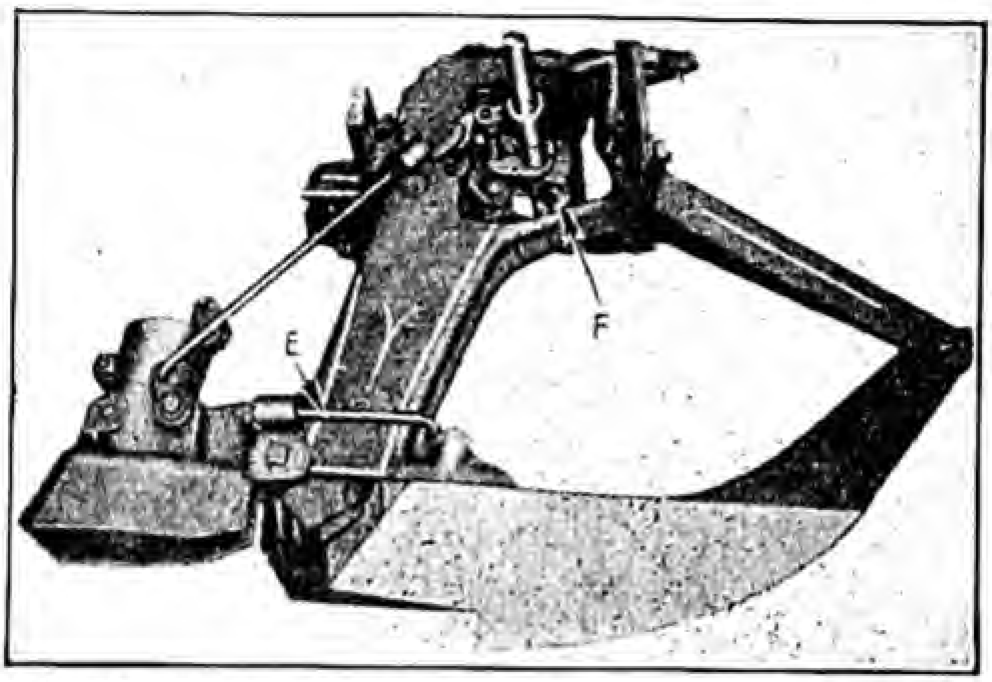


FIG. 662.—Hill-dropping fertilizer attachment that operates automatically with the checking device of the planter.

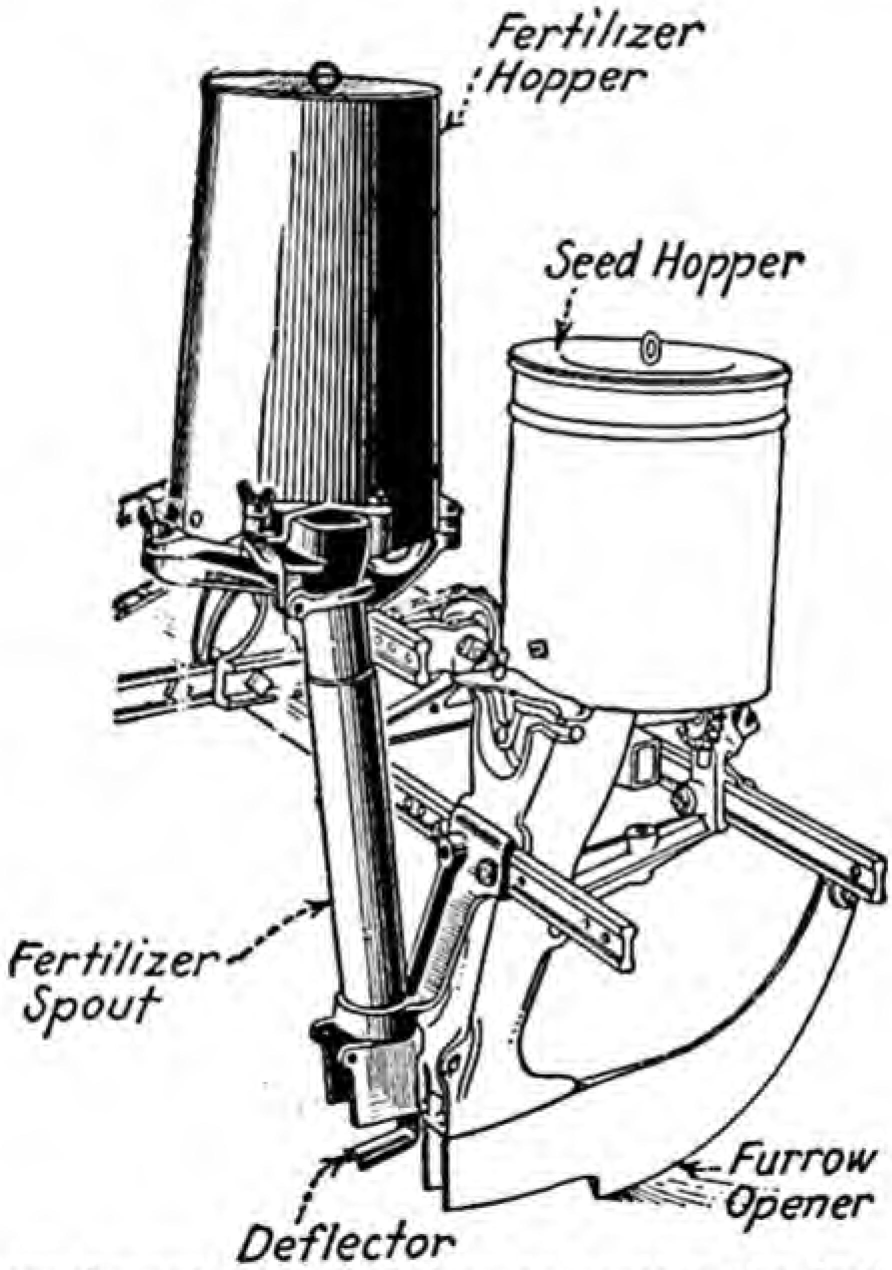


FIG. 663.—Fertilizer attachment with deflector to scatter the fertilizer, reducing direct contact between seed and fertilizer.

band about 4 inches wide and 8 inches long from ½ to ¾ inch directly above the seed. The fertilizer should not be dropped in a mass but should be spread over the whole area.

[1] TRUOG, E., *Reports and Proceedings of the Joint Committee on Fertilizer Application.*

Figure 662 shows how the valve in the lower end of the fertilizer tube is opened in unison with the seed valve.

Figures 267 and 663 show a deflector to scatter and divide the fertilizer, thus preventing it from coming in contact with the seed.

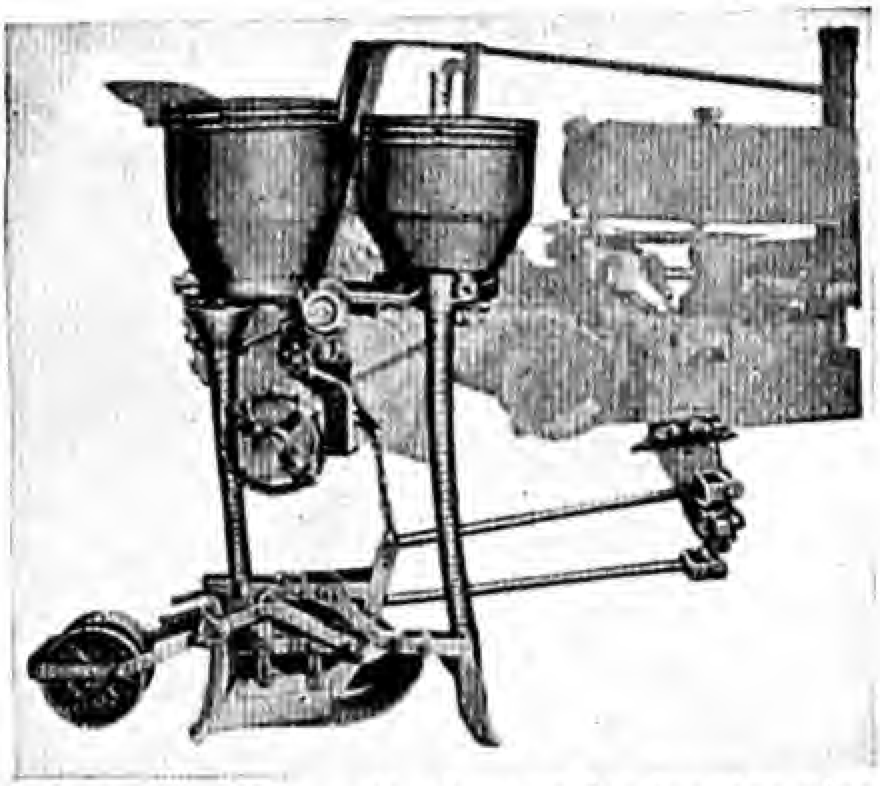


FIG. 664—Fertilizer attachment for tractor planter.

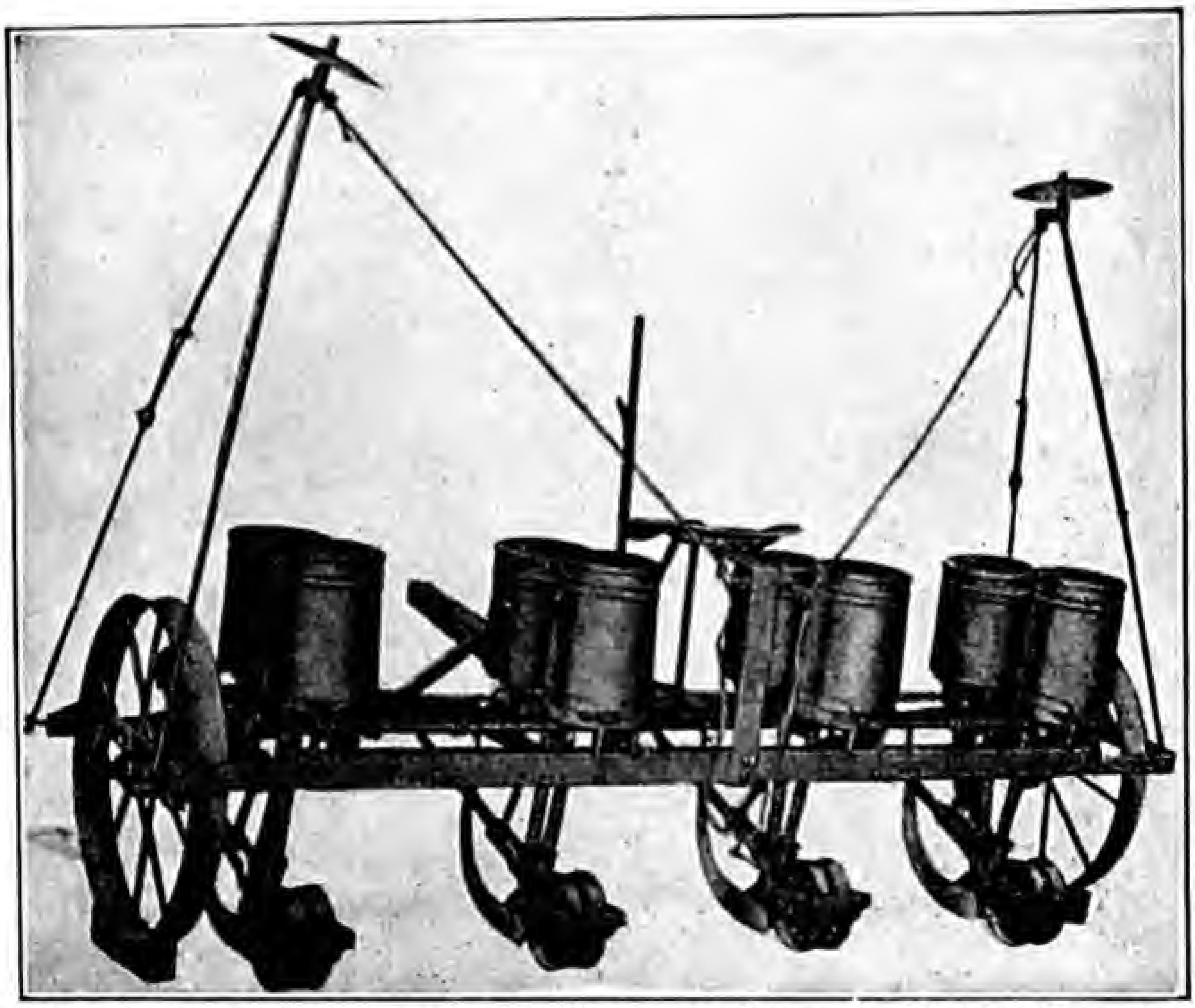


FIG. 665.—Beet and bean planter with fertilizer attachment. The fertilizer is distributed in direct contact with the seed.

544. For Tractor Planters.—Fertilizer attachments have been designed to fit most tractor planters, both the drill and the check-row types. Figure 664 shows a fertilizer attachment for tractor cotton- and corn-drill planter.

545. For Bean and Beet Planters.—A fertilizer attachment for a bean and beet planter is shown in Fig. 665.

546. For Potato Planters.—Fertilizer attachments for potatoes should be adjustable so that the amount of fertilizer applied per acre may be

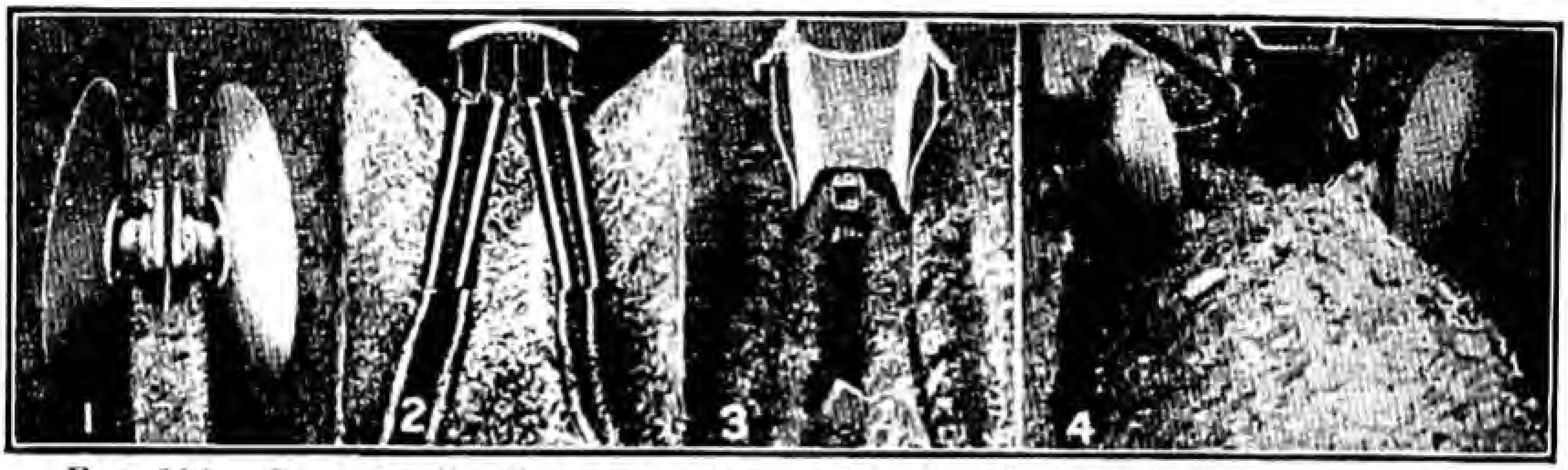


FIG. 666.—Steps in distributing fertilizer when planting potatoes: 1, opening furrow for fertilizer; 2, depositing the fertilizer; 3, opening furrow and dropping potato set; 4, covering potato and fertilizer.

varied from 200 to 1,000 pounds. Since potato sprouts are very sensitive to fertilizer salts, it is essential that the fertilizer be placed along the sides of the seed at about the same level, as shown in Fig. 666.

547. Grain-drill Fertilizer Attachments.—Fertilizer attachments for grain drills consist of a specially constructed hopper having a partition

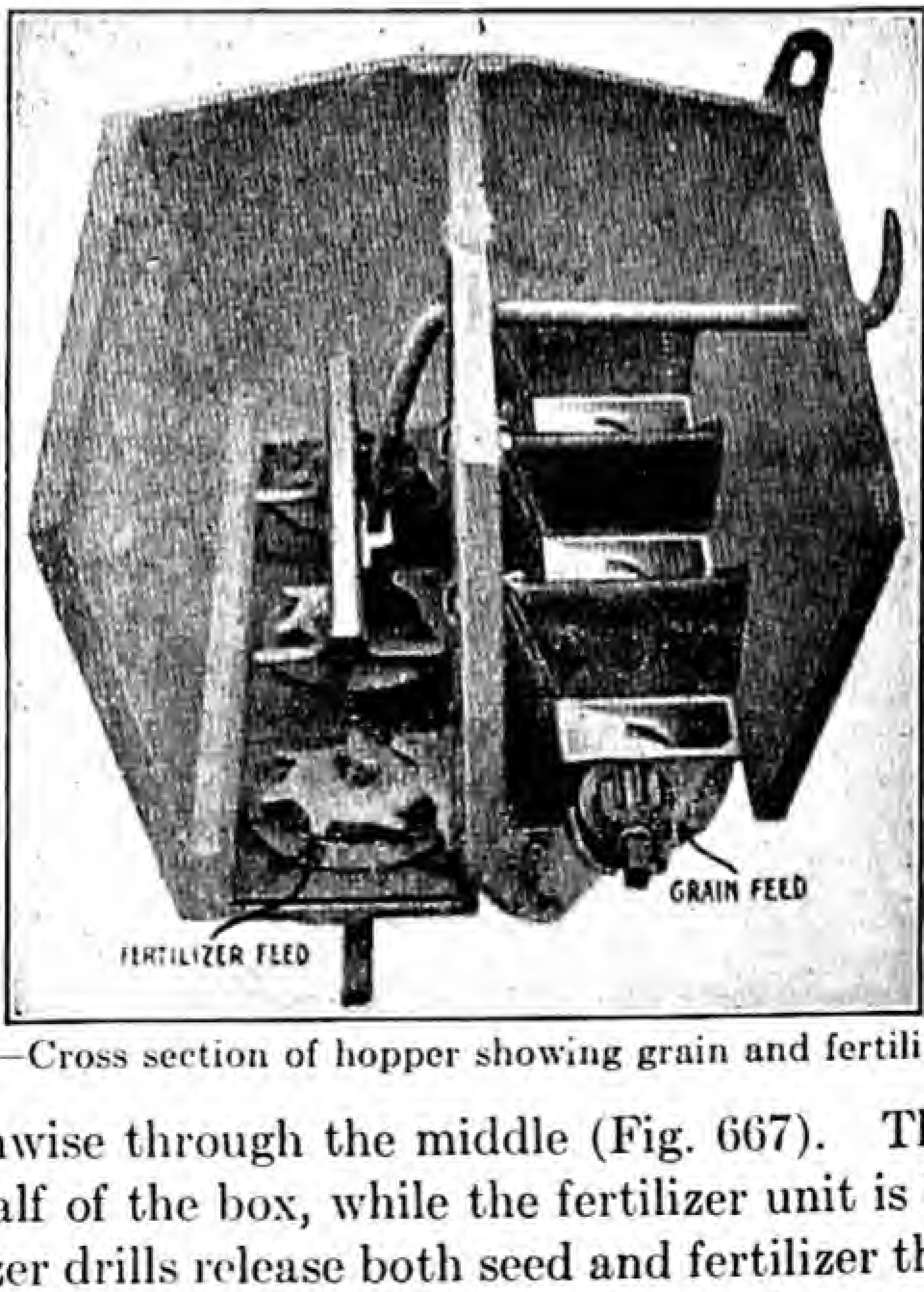


FIG. 667.—Cross section of hopper showing grain and fertilizer feeds.

extending lengthwise through the middle (Fig. 667). The planting unit is in the front half of the box, while the fertilizer unit is in the rear half.

Many fertilizer drills release both seed and fertilizer through the same tube. This is not good practice because the seed are in direct contact

FIG. 668.—Combination grain and fertilizer drill: *A*, fertilizer being released in the same tube in contact with the seed; *B*, separate fertilizer tubes which place fertilizer in the soil above the seed.

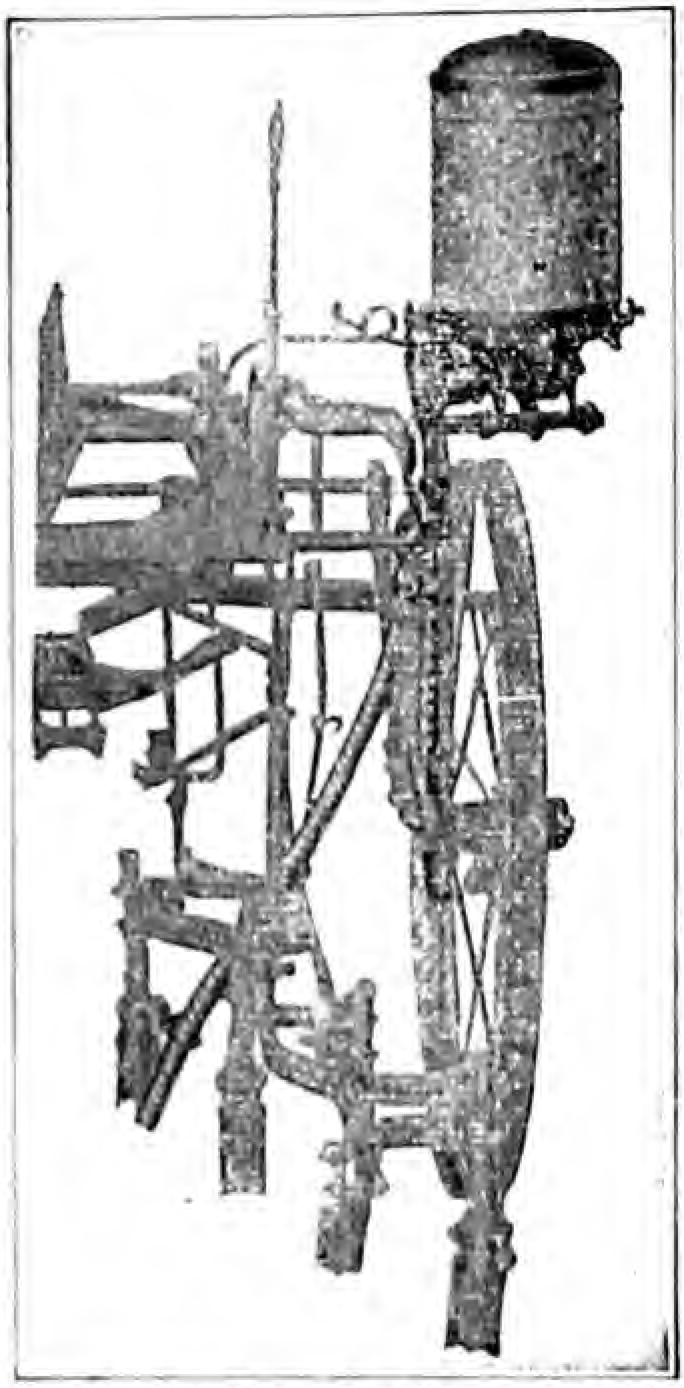


FIG. 669.—Fertilizer attachment for cultivator to apply side dressing to one or both sides of plants while cultivating.

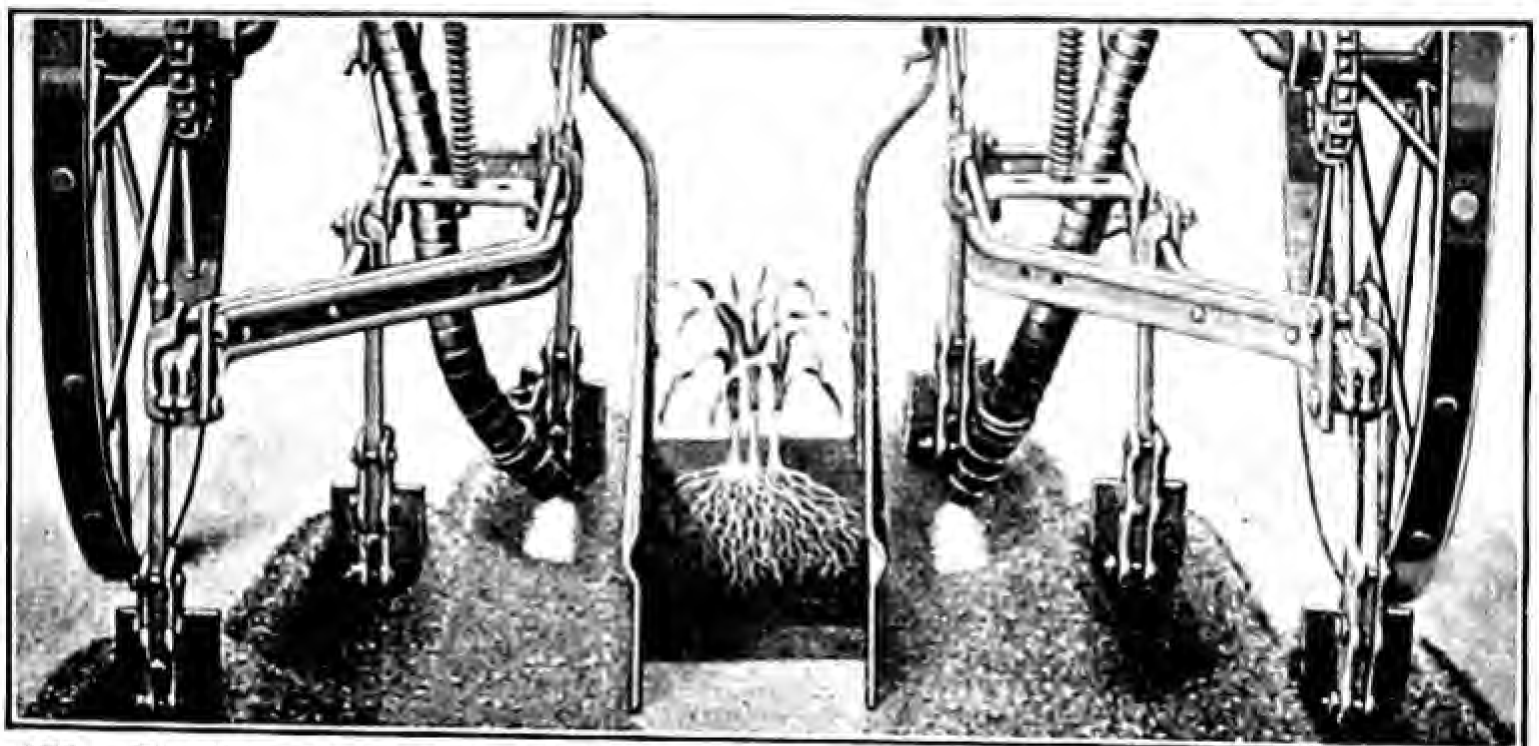


FIG. 670.—Fertilizer being placed in the soil behind the shovel by a cultivator-fertilizer attachment.

with the fertilizer (*A*, Fig. 668). A better method would be to release the fertilizer through separate tubes which will place the fertilizer in the drills above the seed, as shown in *B*, Fig. 668.

548. Cultivator Attachments.—A fertilizer attachment for cultivators to apply a side dressing of fertilizer after the plants are well advanced is

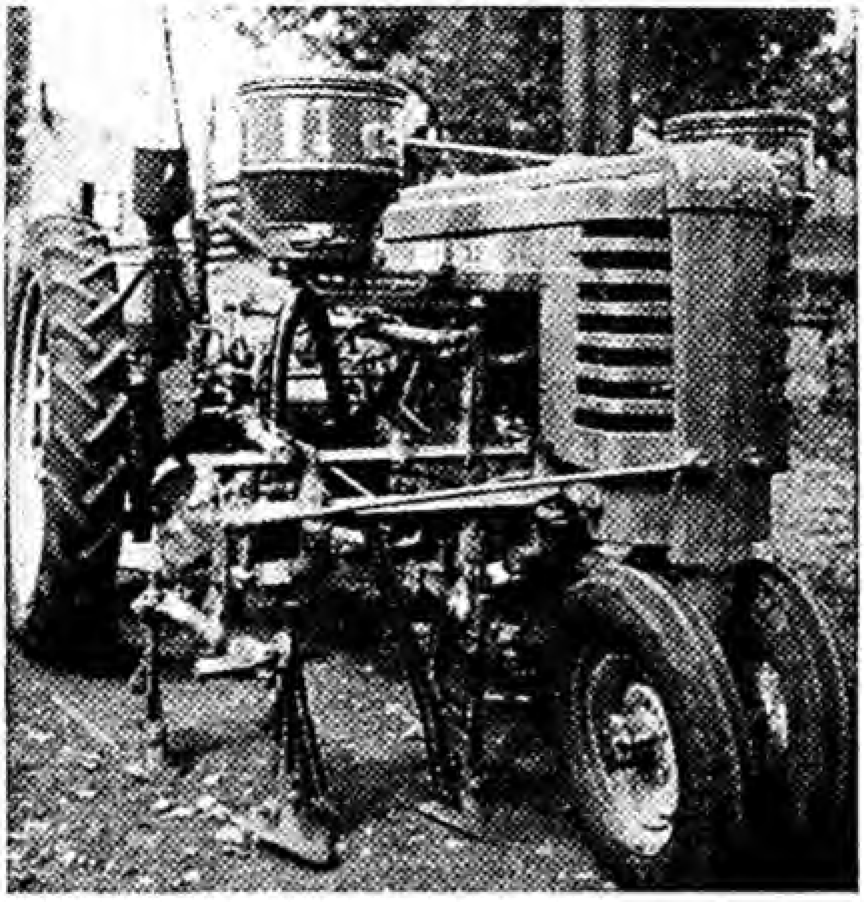


FIG. 671.—Fertilizer attachment for a tractor-mounted cultivator.

shown in Fig. 669. The hopper for the fertilizer is mounted above the wheel—one for each side. The distributing mechanism is driven from the wheel by a sprocket attached to the spokes.

The fertilizer is released through a tube, the lower end of which deposits the fertilizer in the furrow behind one of the shovels, as shown

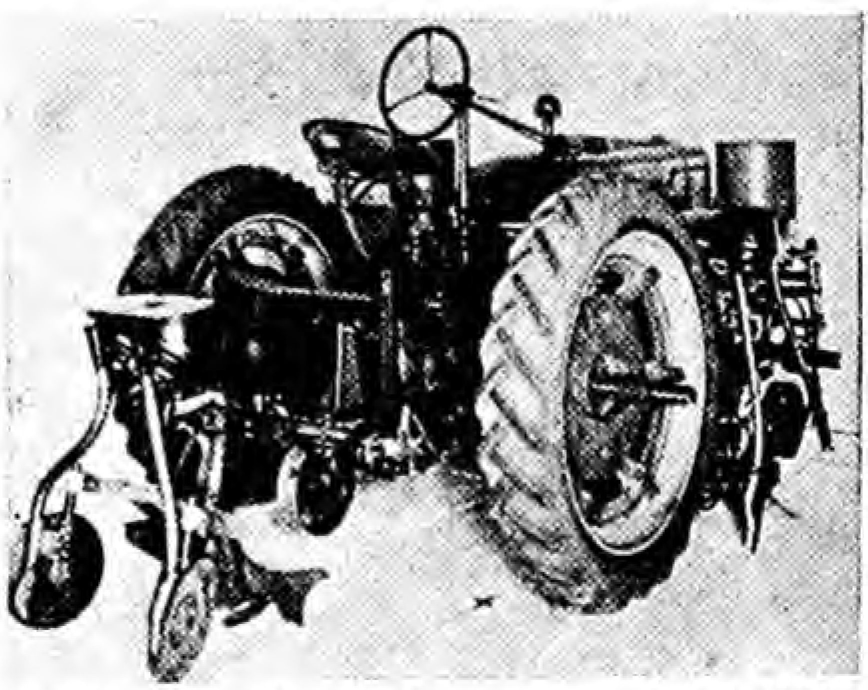


FIG. 672.—Attachment for tractor-mounted lister.

in Fig. 670. Figure 671 shows fertilizer attachment for a tractor-mounted cultivator.

549. Middlebreaker Fertilizer Attachment.—Figure 672 shows a three-row tractor-mounted lister equipped with a fertilizer attachment

for placing the fertilizer behind the lister bottom in the sides of the bed. Planter hoppers may be substituted for the fertilizer hoppers, and legume seed may be planted in the sides of the ridges.

BROADCAST LIME AND FERTILIZER SOWERS

Figures 673 and 674 show machines suitable for broadcasting either lime or fertilizer. Usually, a wire screen is used in the top of the hopper to remove large lumps and prevent clogging of the feeds.

FIG. 673.—Two-wheel broadcast fertilizer and lime sower.

The feeds drop the lime or fertilizer on a scattering board, which deflects and scatters the material so that it will be more thoroughly broadcasted.

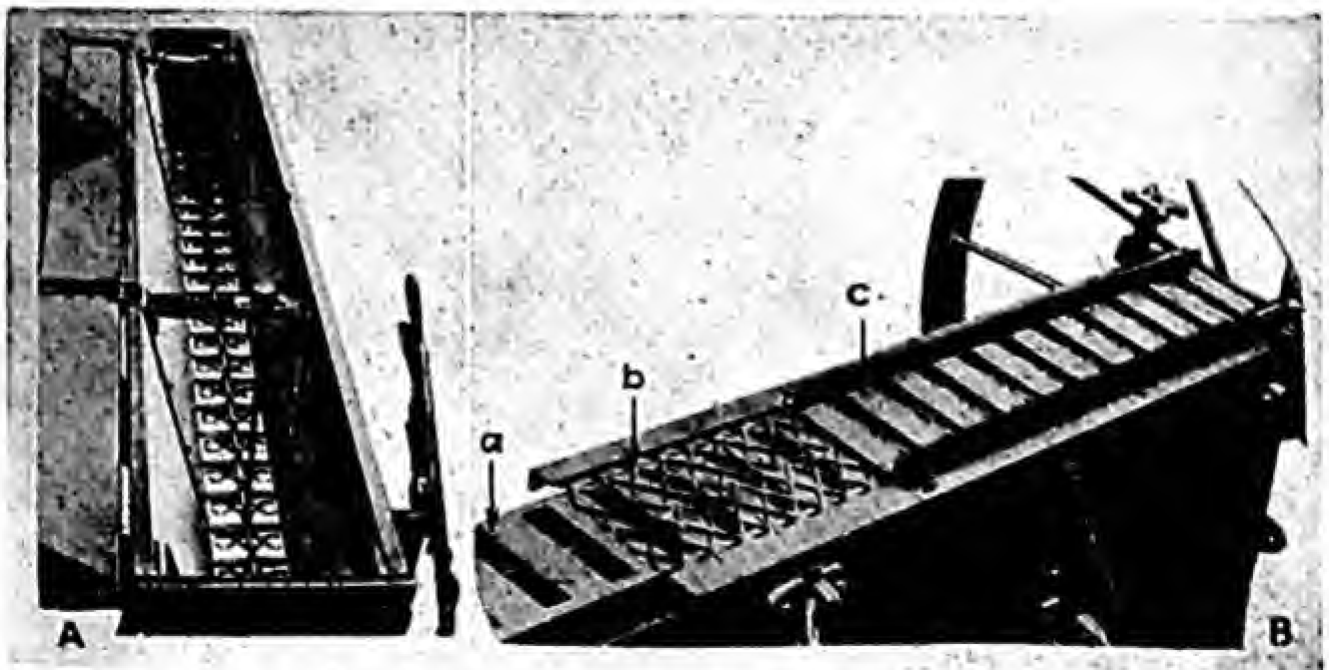


FIG. 674.—Two views of agitator or reciprocating broadcast fertilizer feed: *A*, looking into box; *B*, box inverted with feed plates and lower bottom cut away; *a*, upper bottom; *b*, perforated feed plate; *c*, lower bottom with outlets.

An inexpensive end-gate lime spreader is shown in Fig. 675. It is similar in construction to the end-gate seeder, with the exception that the hopper is flush with the wagon box and the revolving scattering discs are much closer to the ground.

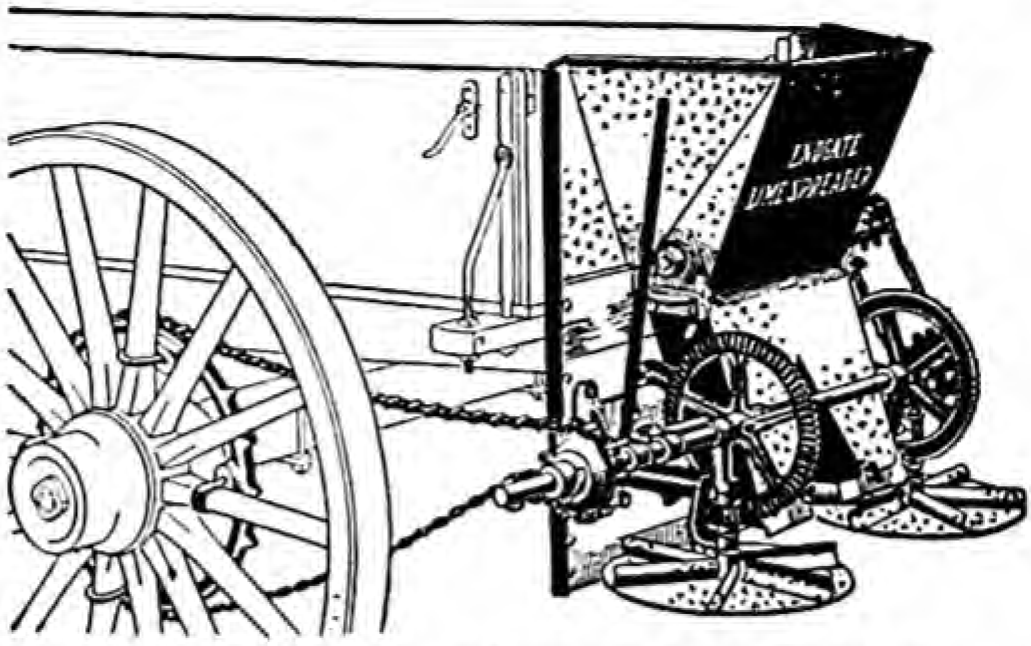


FIG. 675.—End-gate lime sower or spreader.

FERTILIZER FEEDS

The efficiency of any fertilizer-distributing machine depends upon the proper handling of the fertilizer by the feeding mechanism. A number of factors will influence the efficiency of the feed, some of which are

1. Climatic conditions, based on temperature and rainfall.
2. Amount of fertilizer to be applied.
3. Kind of fertilizer:
   a. Chemical composition.
   b. Physical state.

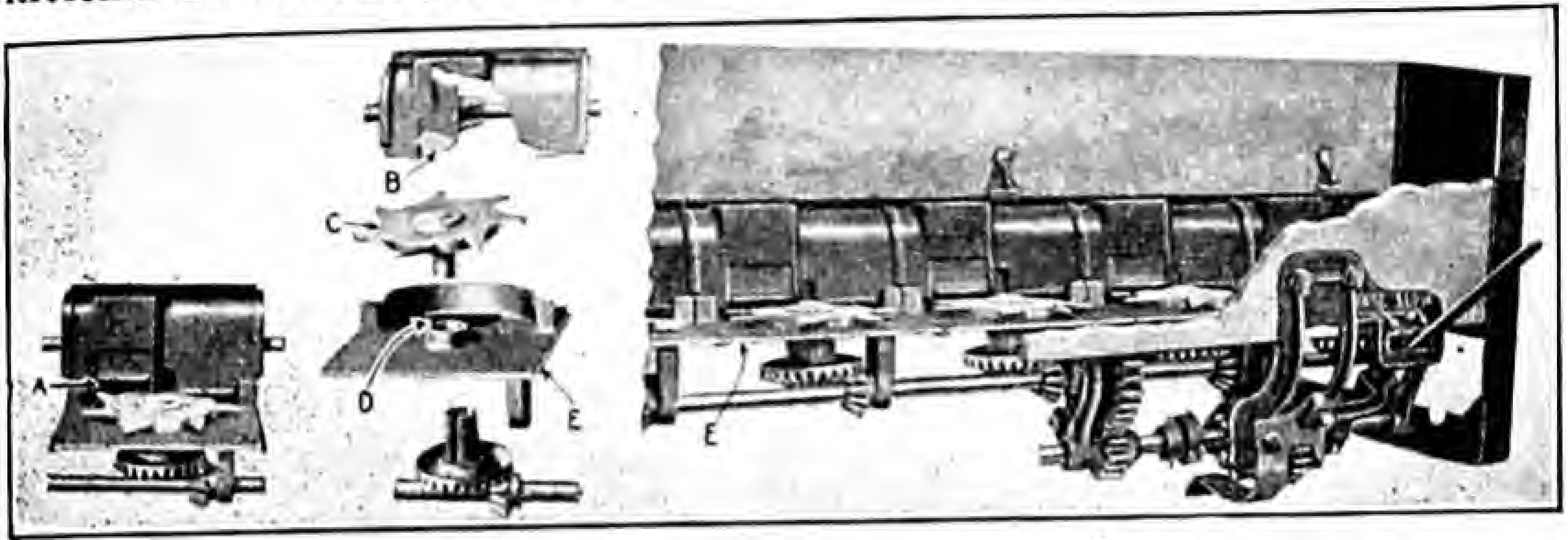
Many attempts have been made to design a fertilizer feed that will handle any and all kinds of fertilizer, distributing any desired quantity. As a result, several different types are being used. These may be classified as

1. Finger feed.
2. Marks or cone feed.
3. Screw-conveyor feed.
4. Revolving-bottom feed.
5. Vibrator feed.
6. Rotary feed.
7. Winged-wheel feed.
8. Top-delivery feed.

550. Finger Feed.—The finger feed is also known as the *star* or *wizard* feed. It is the most generally used type of fertilizer feed. Figures 676 to 678 show the various installations, adjustments, parts, and methods of drive.

The feed consists of a finger plate in the bottom of the box. The fertilizer is caught by the fingers on the plate and carried through the gate opening to the back of the box where it is dropped into the spout. This type of distributor is used in many different types of attachments but is more often used in the fertilizer drills.

The quantity of fertilizer distributed per acre is varied by changing the speed of the plate and by regulating the gate opening. The speed of the plate is controlled in a manner almost identical with that of the internal double-run grain feed, as shown in Fig. 342.



A *B* *C*

Fig. 676.—Fertilizer feed taken apart in *B*; assembled in *A*; and a section of the hopper with the feeds installed in *C*. *A* and *B*, adjustable gate; *C*, revolving disk; *D*, opening in hopper bottom for fertilizer to drop through; *E*; hopper bottom.

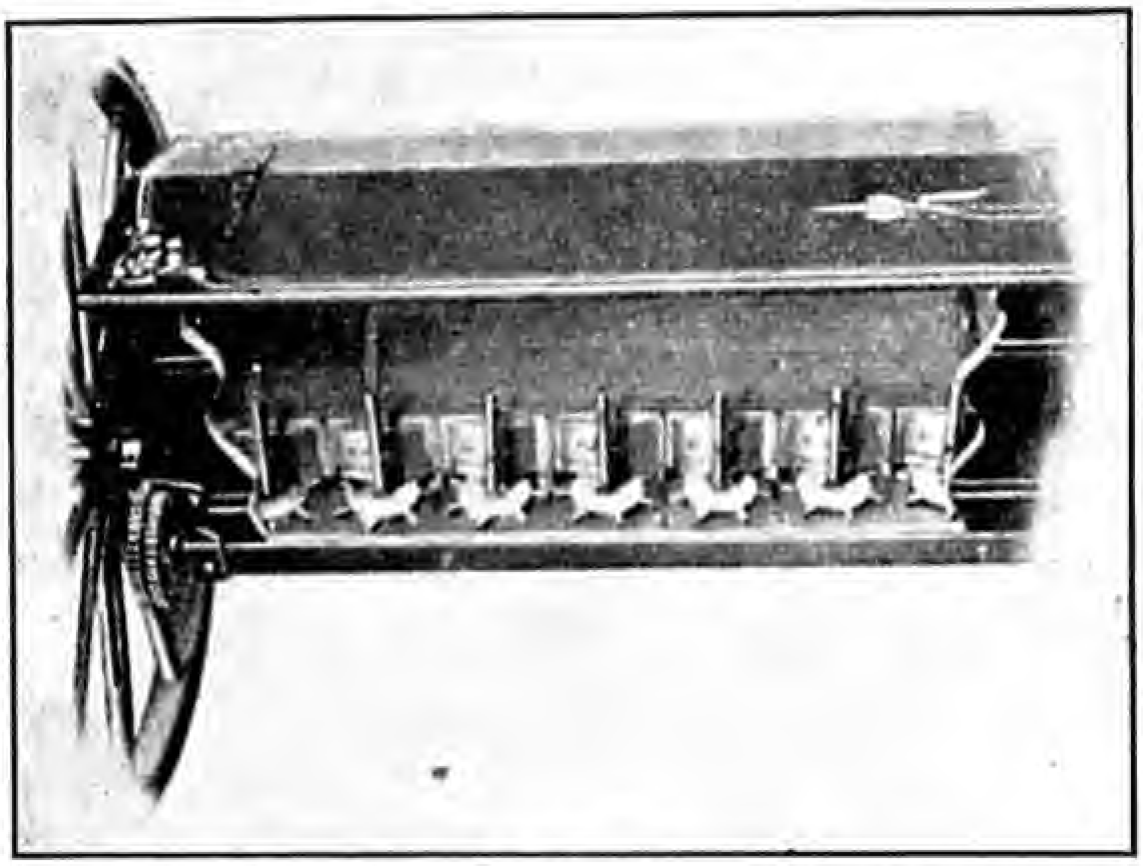


Fig. 677.—Finger feed with vertical agitators.

551. Marks or Cone Feed.—This consists of an inverted cone which has a projecting lip, the whole of which is stationary (Fig. 679). Beneath this lip there is a revolving plate that brings the fertilizer to the lip, which gathers up a certain amount and carries it to the center of the cone and drops it through the spout into the soil. The quantity per acre is controlled by varying the speed of the plate beneath the cone. Different-sized cones can be secured for distributing different types of fertilizers. They are known as the *standard*, *half-standard*, *double-standard*, and *hen manure*. The greatest objection to this type of feeder is that damp fertilizer will stick to the inside and fail to drop out through the spout.

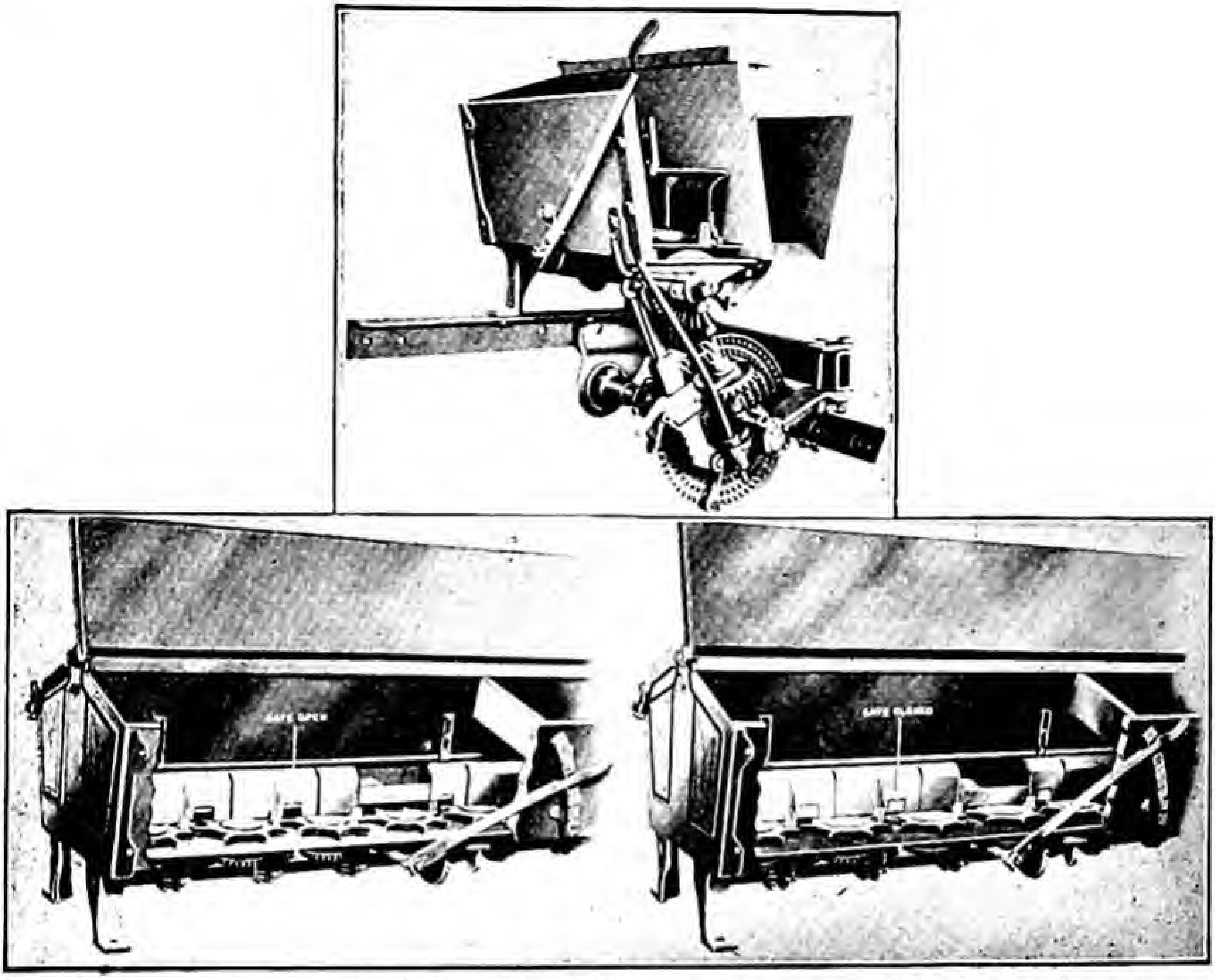


FIG. 678.—Fertilizer feed showing gate closed and open, and driving mechanism.

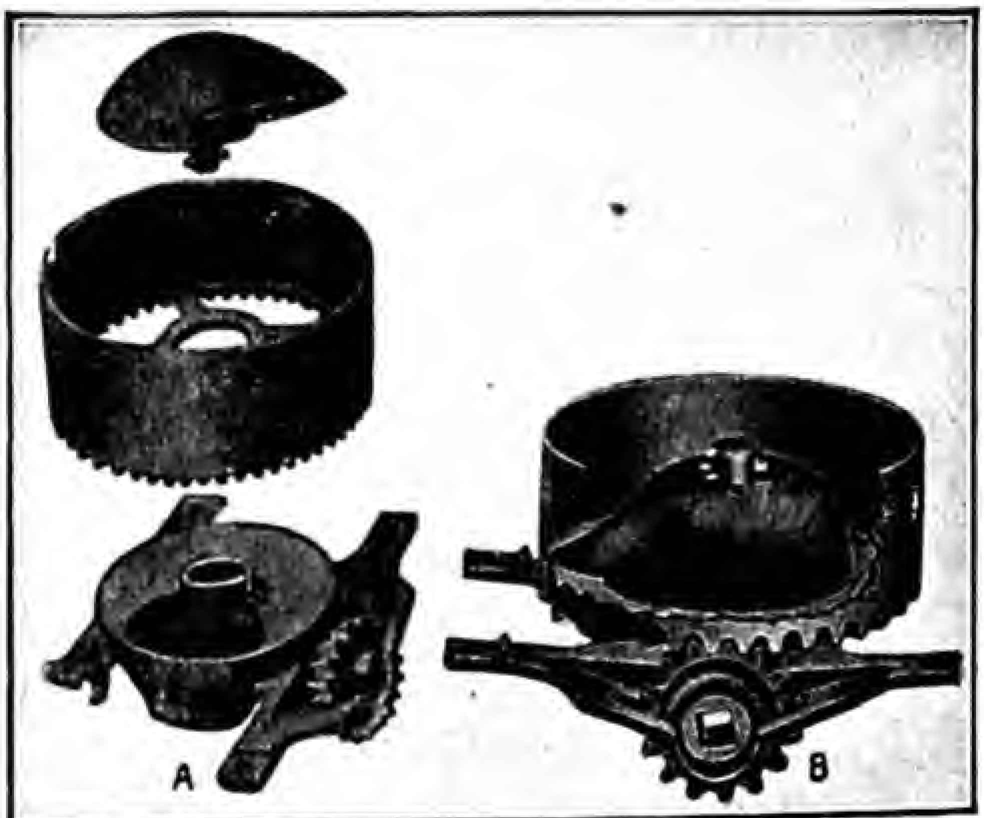


FIG. 679.—The marks or cone fertilizer feed: *A*, various parts of the feed; *B*, the feed assembled.

552. Winged-wheel Feed.—Figure 680 shows a fertilizer sower that is equipped with winged wheels to distribute the fertilizer. The fertilizer is carried by a shaker box to the feeds, which drop it on the distributing wheels.

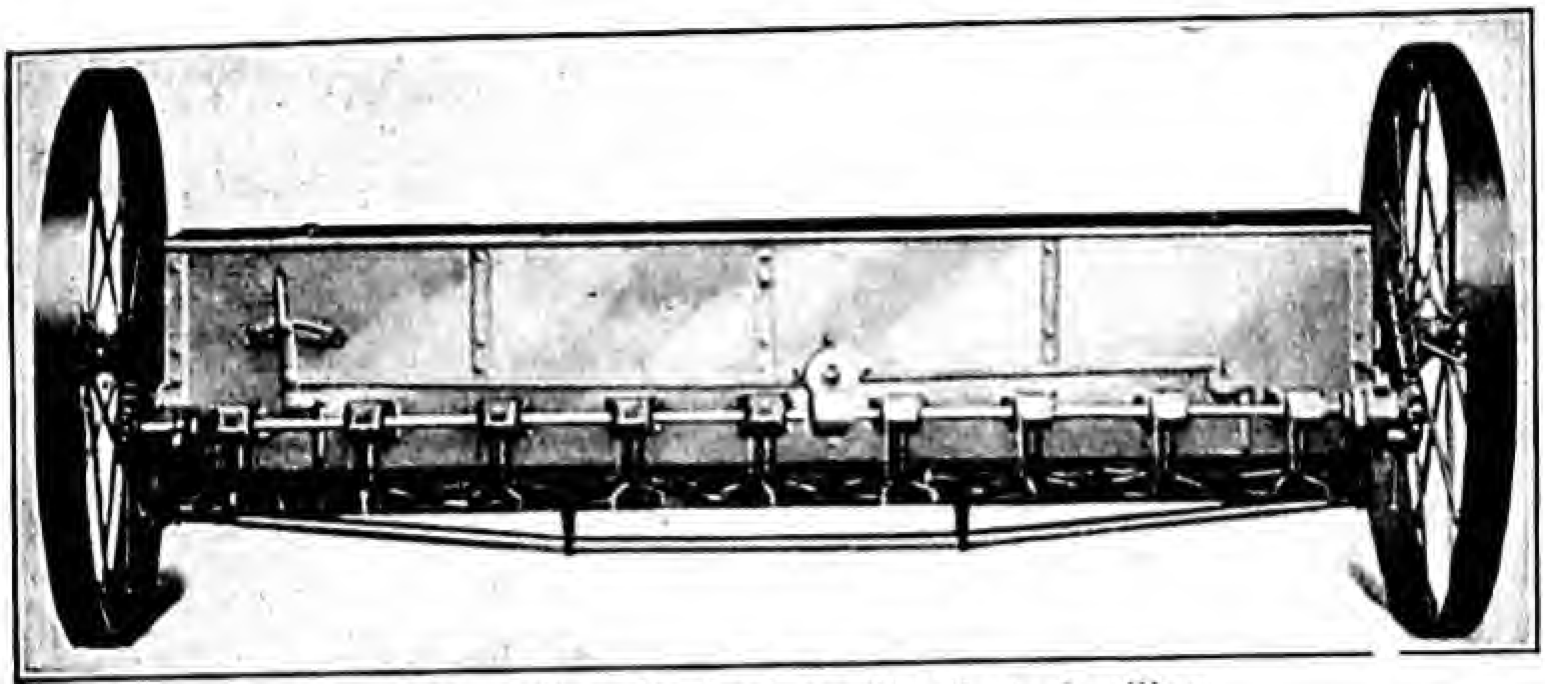


Fig. 680.—Winged wheels to distribute fertilizer.

553. Screw-conveyor Feed.—This type of feed is shown in Fig. 681. A screw conveyor is placed in the bottom of the hopper to convey the fertilizer out. Above the conveyor is an agitator to keep the fertilizer from bridging.

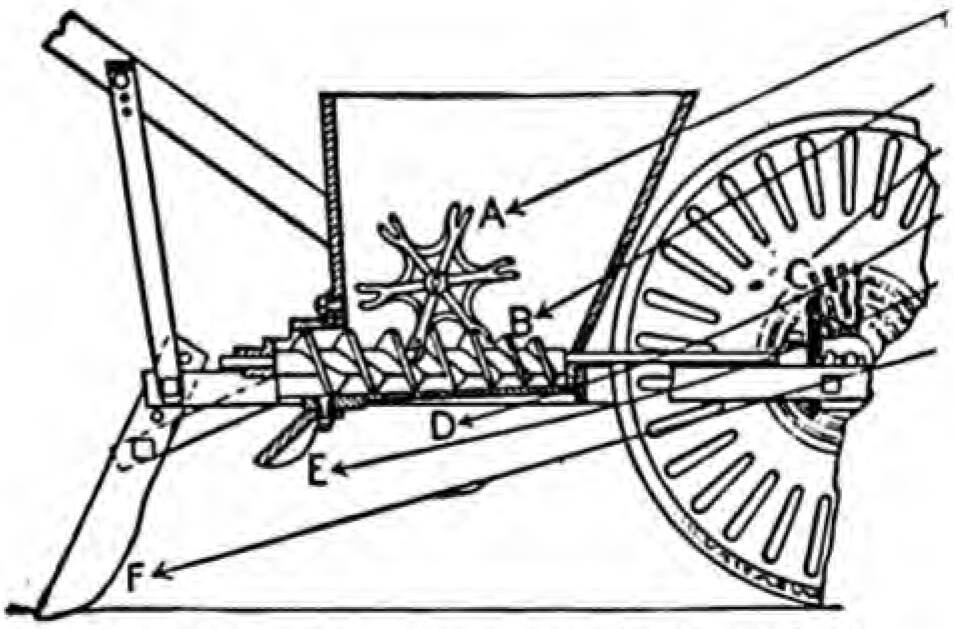


Fig. 681.—Screw-conveyor fertilizer feed.

554. Revolving-bottom Feed.—The revolving-bottom fertilizer feed, as shown in Fig. 682, is used rather extensively on attachments for planters and cultivators. The fertilizer in the hopper rests on a rotating bottom; as the bottom revolves, the contents are constantly agitated to keep them from bridging. As the bottom revolves, the outer portion of the fertilizer is carried against a stationary feed plow or inclined plane, which scoops out a quantity and deflects it into the fertilizer tube.

The amount of fertilizer is regulated by raising or lowering the hopper. Raising increases the feed, while lowering decreases it.

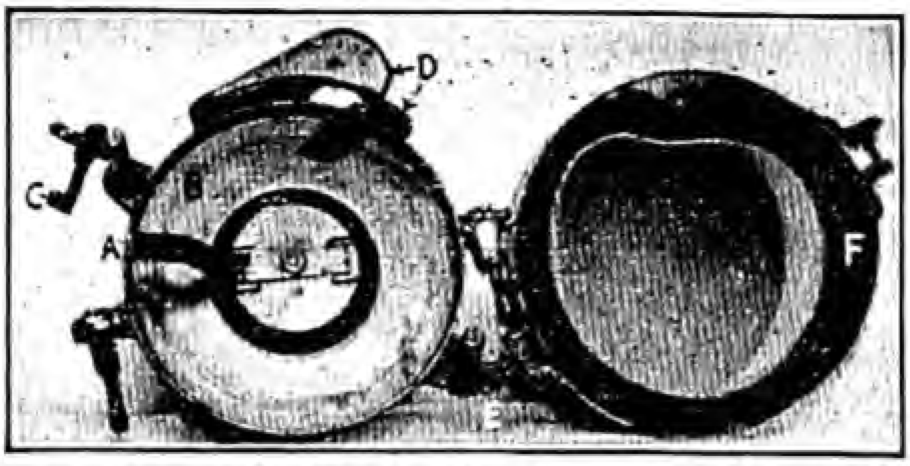


FIG. 682.—Working parts of fertilizer attachment shown in Fig. 627: *A*, shows the revolving bottom *B* with agitator attached; the stationary plow *D* deflects a quantity of the fertilizer over the side into the spout; *C*, control cranks; *F*, hopper which fits on the hopper bottom.

555. Vibrator or Knocker Feed.—The vibrator feed is used both on the machines that apply fertilizer as a separate operation and on those that apply it at the same time seed are sown.

Figure 683 shows the vibrator feed arrangement mounted on a one-row riding planter. The vibrator arm is operated by a detachable gear on the main axle. An adjustable gate in the bottom of the hopper allows more or less fertilizer to be shaken out, depending on the setting.

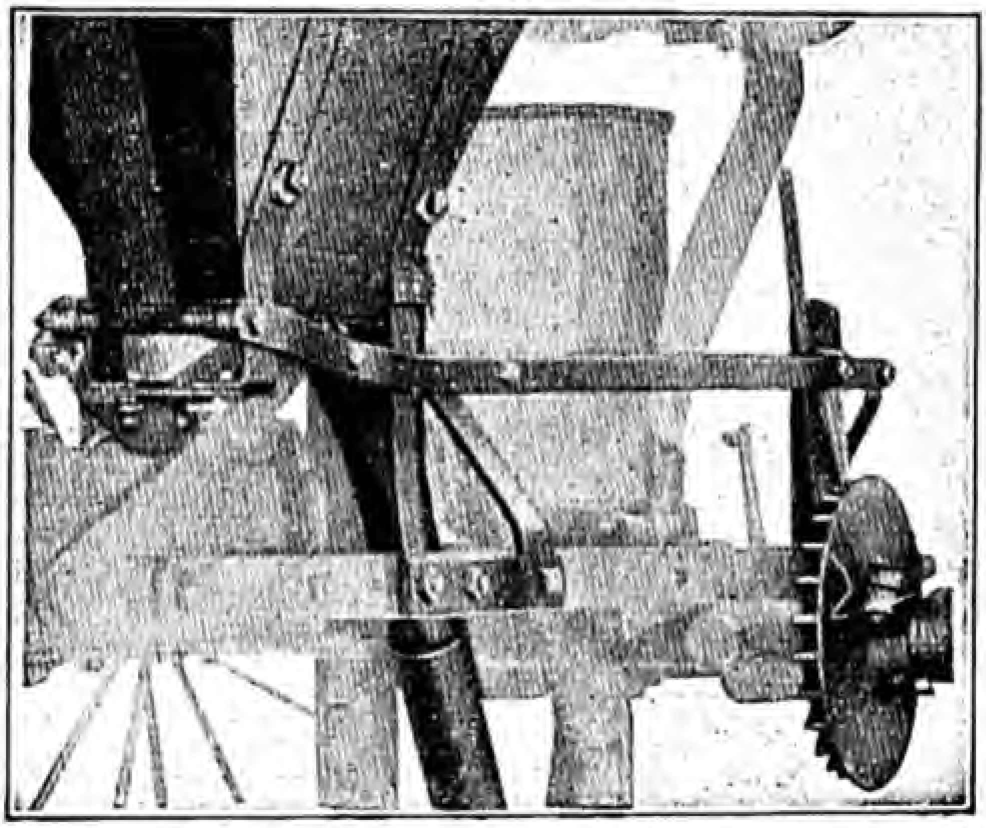


FIG. 683.—Vibrator or knocker distributor mounted on a one-row riding cotton and corn planter.

556. Rotary-winged Feed.—For lime and fertilizer sowers special rotary-winged feeds are used, as shown in Fig. 684. The feed shafts are in two parts and can be lifted out to facilitate cleaning of the hopper. One-half the feed is driven by each wheel.

557. Top-delivery Feed.—The top-delivery feed (Fig. 685) will distribute accurate amounts of fertilizer in a continuous uniform band. The hopper revolves and turns a screw, which raises the hopper bottom so that from one to four stationary adjustable-delivery blades in the

hopper head scrape off a uniform amount of fertilizer into the tubes. By changing the size of either gears or sprockets, the speed at which the hopper revolves can be changed, thus changing the rate of fertilizer application.

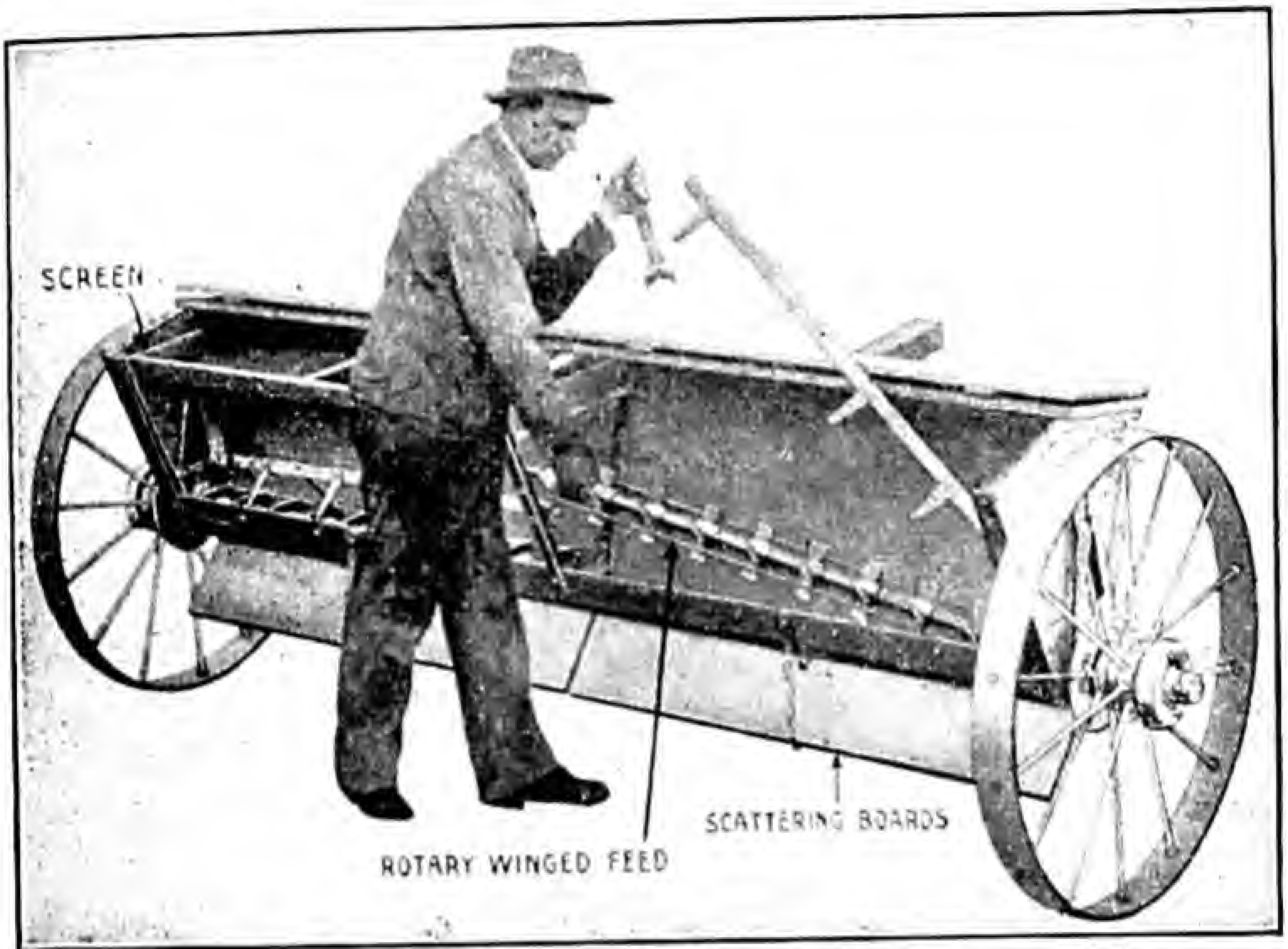


FIG. 684.—The rotary-winged fertilizer feed is easily removed.

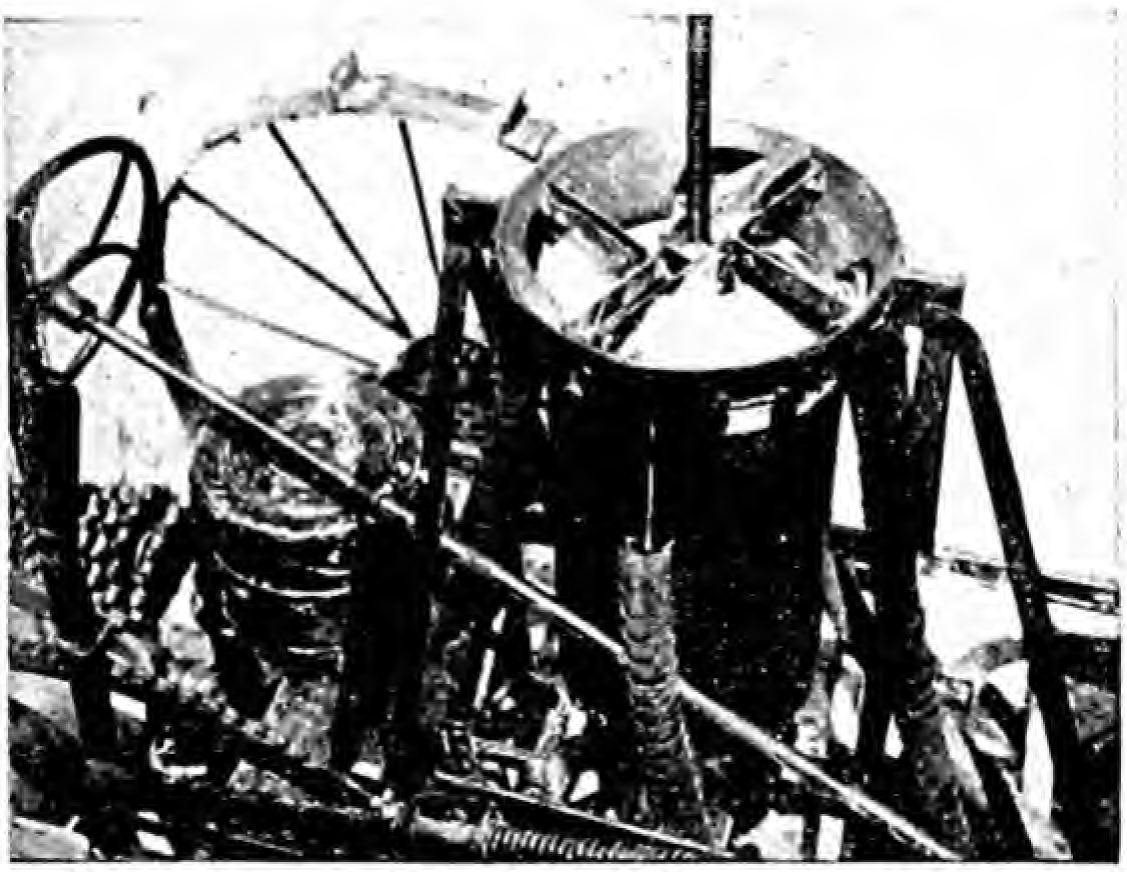


FIG. 685.—Top-delivery fertilizer feed. (*U. S. Dept. Agr. Bur. Agr. Eng.*)

PART XII

TRANSPORTATION EQUIPMENT

CHAPTER XXXI

WAGONS, MOTOR TRUCKS, AND TRAILERS

Among the various changes taking place in farm equipment and agricultural practices is the method of transporting farm commodities. Three general types of vehicles are used to transport farm products and supplies on the farm and to and from market, namely, the wagon, the motor truck, and the automobile or truck trailer. The use of the farm wagon is now confined almost entirely to the farmstead, but the motor truck and automobile trailer are used not only on the farm but for transporting commodities to and from market. Fast motor vehicles are rapidly replacing slow horse-drawn wagons.

THE FARM WAGON

There are two classes of wagons, the farm truck and the farm wagon.

558. The Farm Truck.—The farm truck consists of front and rear gears[1] and four low wheels of the same diameter (Figs. 686 to 690).

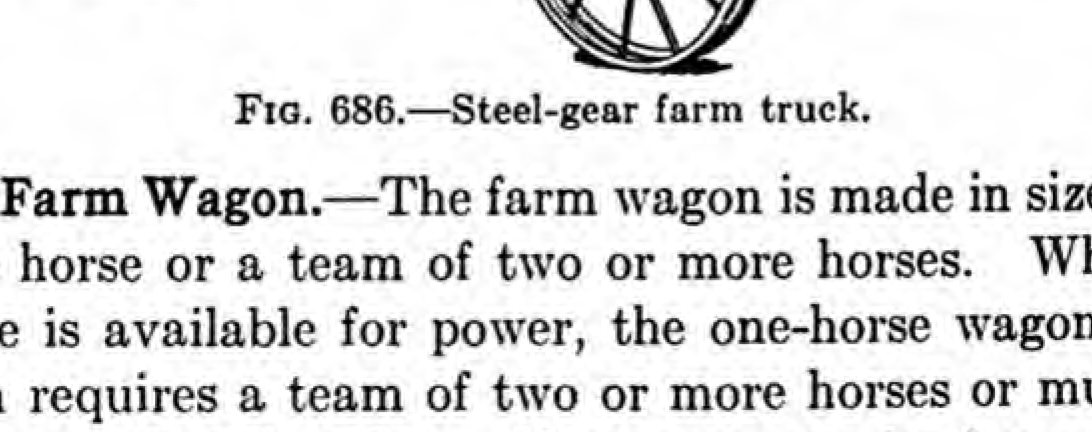


Fig. 686.—Steel-gear farm truck.

559. The Farm Wagon.—The farm wagon is made in sizes suitable for use with one horse or a team of two or more horses. Where only one horse or mule is available for power, the one-horse wagon is used, but where a farm requires a team of two or more horses or mules, the two-horse wagon prevails (Fig. 691). Heavy wagons for four, six, and eight horses can be obtained. There is usually a difference of about 4 inches in the diameters of the rear and front wheels.

[1] The wagon without the box is termed the *running gear*.

Fig. 687.—A farm-wagon truck equipped with rubber-tired wheels with drop-center rims as used in automobiles.

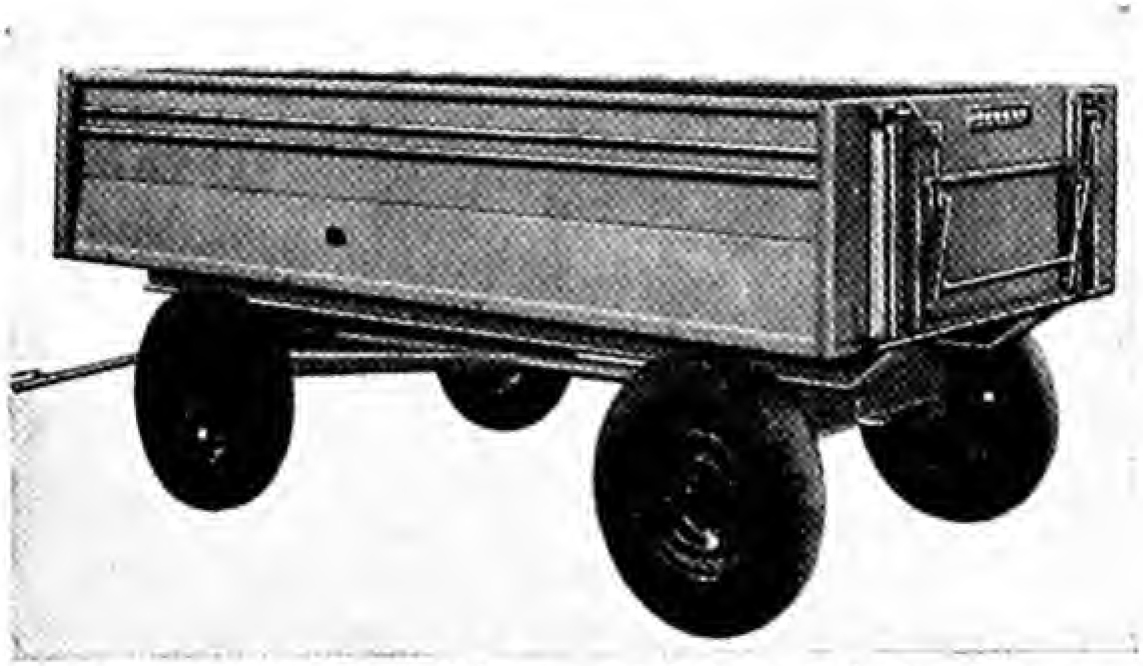


Fig. 688.—Wide all-steel boxes are being made for farm use.

Fig. 689.—Trailer-wagon box with flaring top hitched behind corn picker.

560. Trailer Cart for Rice.—Where rice is combined in fields that are too wet and soft for the operation of trucks, a special trailer cart is used to haul the rice from the combine to the truck located on a dry road. The cart is pulled about the field with a tractor. Many different shapes and sizes are used by farmers, but the one shown at the right in Fig. 693

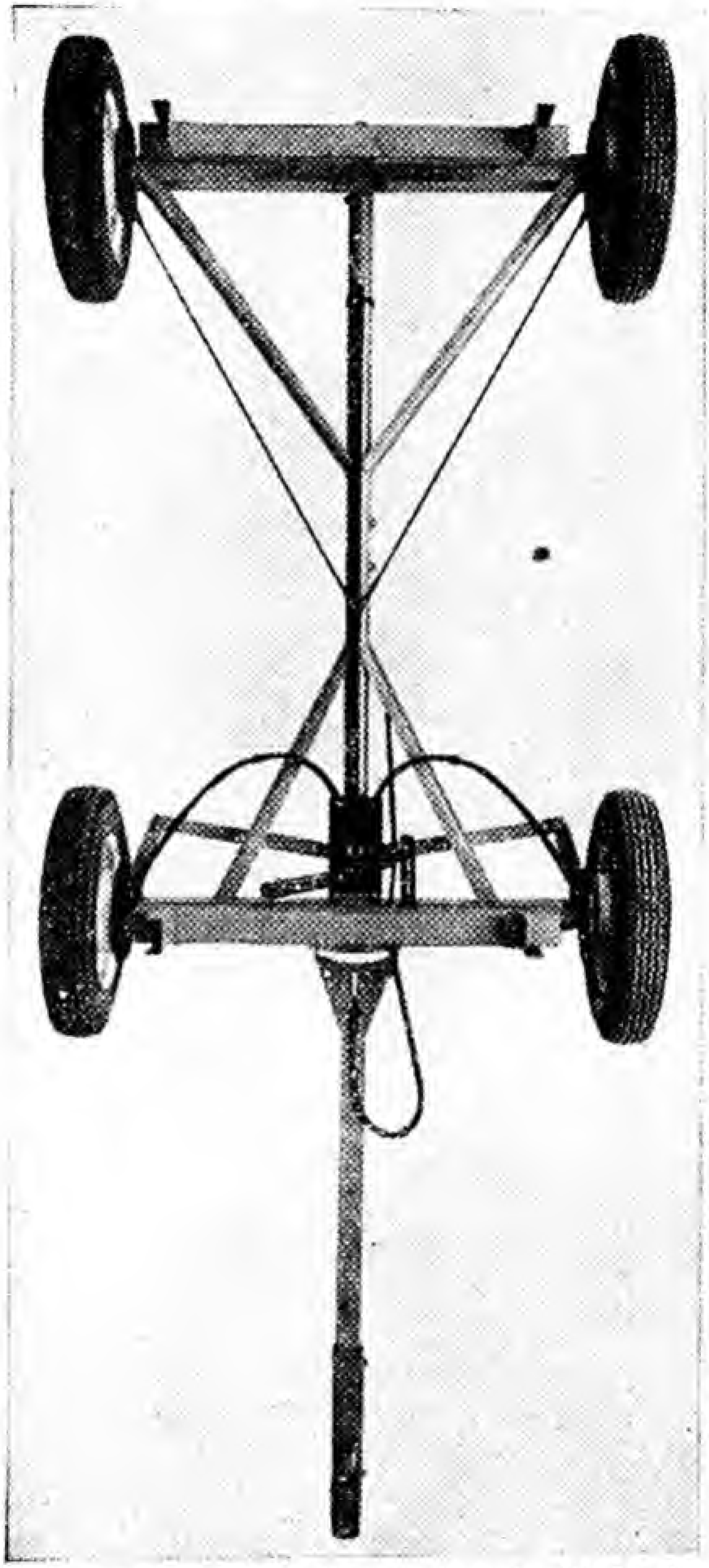


Fig. 690.—Farm-wagon truck trailer equipped with brake attachment.

is quite popular. It consists of an inverted pyramidal frustum and a screw-auger-type elevator, which is attached to the bottom so that the rice can be transferred from the cart to the truck. The elevator auger is power-driven from the power-take-off of the tractor. The cart wheels are equipped with large, tractor-type balloon tires so they will not sink deep in the soft soil.

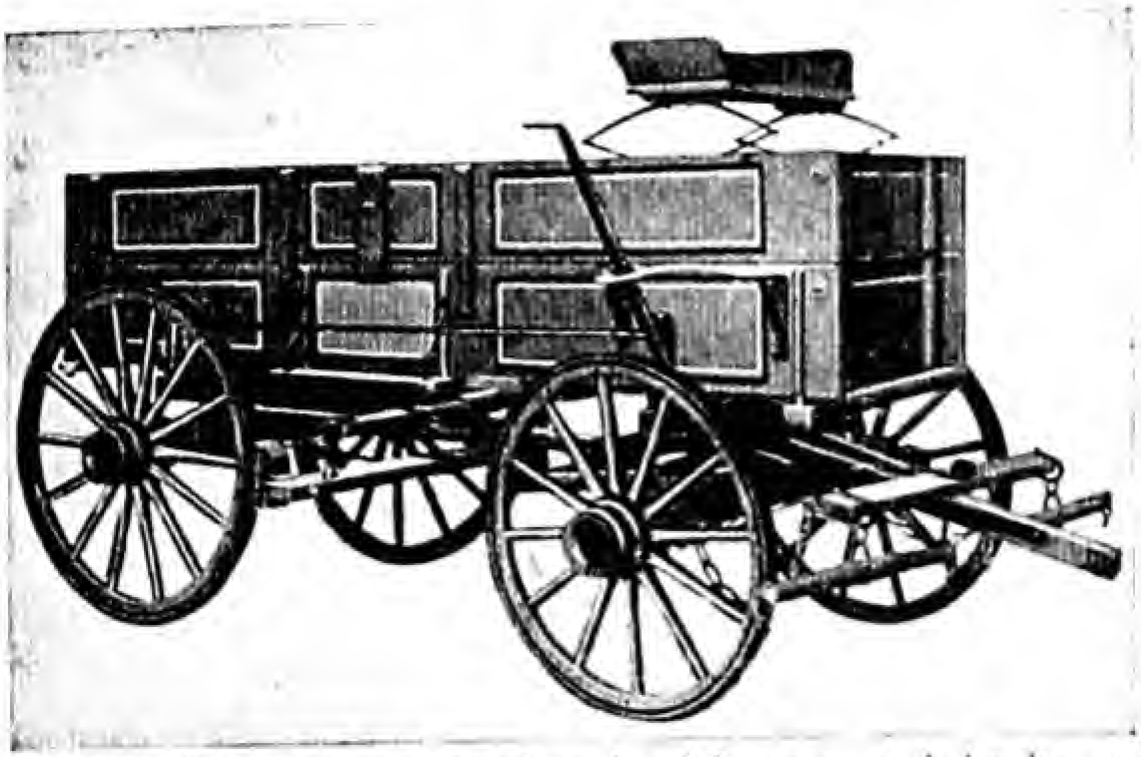


FIG. 691.—Two-horse farm wagon, equipped with seat and brake supplied as extra equipment.

FIG. 692.—Several styles of tongue that can be used either for horses, tractor, or truck.

FIG. 693.—Rice carts and wagons for hauling rice across soft muddy fields.

MOTOR TRUCKS

The motor truck is becoming as essential to the farmer as it is to the merchant. The type of hauling required by the truck varies with the type of farming, which may be dairy, poultry, general livestock, grain, fruit,

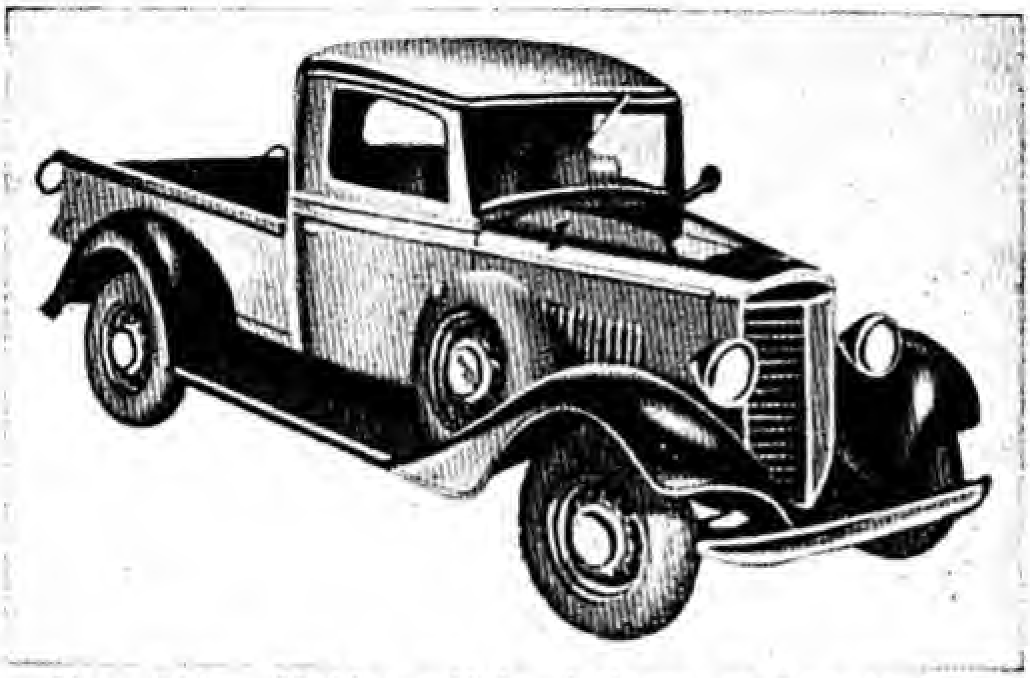


FIG. 694.—Half-ton light-delivery pickup truck.

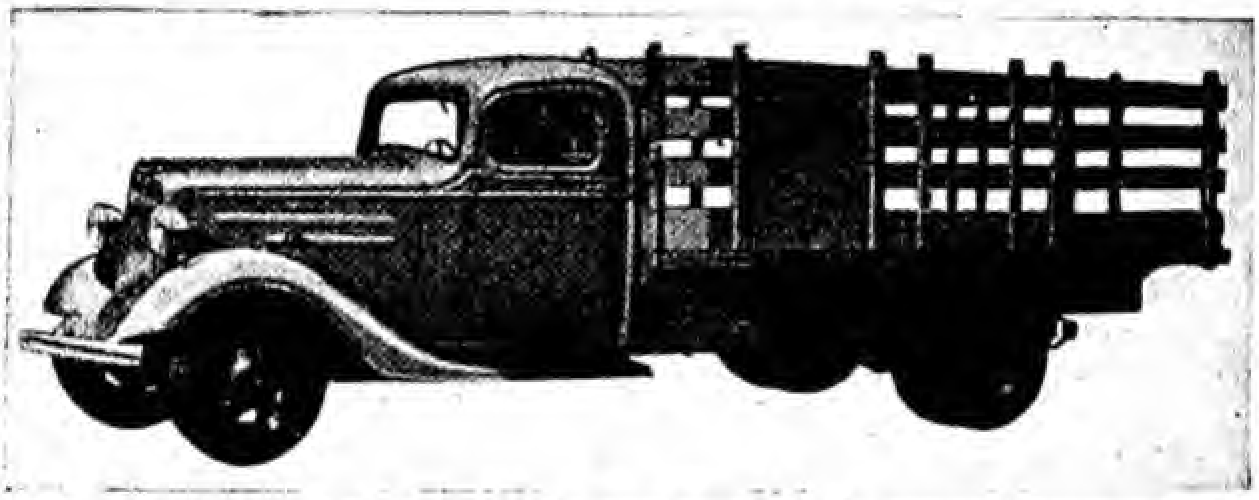


FIG. 695.—One-and-one-half-ton truck equipped with general-purpose stake body.

FIG. 696.—One-and-one-half-ton truck with double-section body suitable for either regular hauling or livestock.

vegetable gardening, or cotton farming. Consequently, the type and size of truck will vary according to the needs of the particular type of farm. The sizes of motor trucks are rated according to capacity and range from ½ ton to 3 tons. The popular sizes are ½, 1, and 1½ ton. Figure 694 shows a ½-ton light-delivery pickup truck, and Fig. 695 shows a 1½-ton stake-body truck. Tight box bodies for hauling grain are available.

561. The Jeep.—The jeep, which was developed for the Army during the Second World War, is classed as a $\frac{1}{4}$-ton four-wheel-drive truck. It makes an excellent general-utility vehicle for use on farms and ranches. The Army jeep (Fig. 698) has been redesigned for civilian use (Fig. 699)

FIG. 697.—One-and-one-half-ton truck equipped with high rack body suitable for livestock.

and accessories developed so that machines can be driven by the power-take-off or by the belt pulley.

562. Cost of Operating Trucks.—The cost of operating a truck will vary with the size, type of hauling, road conditions, size of load, topography, and other factors.

FIG. 698.—Army jeep pulling special trailer for transporting horses.

Rasmussen and Williamson[1] found in their studies of motor-truck operation that the cost per mile varied from 5.3 cents for the $\frac{1}{2}$-ton size for hauling crops to 8.2 for the 2-ton size. The cost for operating a 3-ton truck was 9.6 cents per mile. The average for all sizes of trucks was 7.5 cents per mile.

[1] *N. Y. Agr. Expt. Sta. Bull.* 747, 1941.

FIG. 699.—Universal or peacetime-model jeep pulling four-wheel trailer wagon loaded with cotton.

TRAILERS

There is a decided trend in farm transportation to use trailers behind both trucks and automobiles. When a small trailer is hitched behind an automobile, farm products and supplies can be transported to and from market at little extra expense. A trailer also saves the family car from much abuse, and the occupants are able to ride in comfort. A trailer will add much to the capacity of a truck, especially the small light-delivery pickup type.

563. Types of Trailers.—Trailers may be classed, according to their wheel equipment, as one-, two-, and four-wheel types. There are also, of course, the two-wheel heavy-duty industrial trailers equipped with dual tires.

564. The One-wheel Trailer.—Figure 700 shows a light one-wheel "trailerette," which provides a convenient means of transporting small light articles. Open or closed wheels can be supplied. Brackets on each of the two front corners attach to the bumper of the car, thus giving

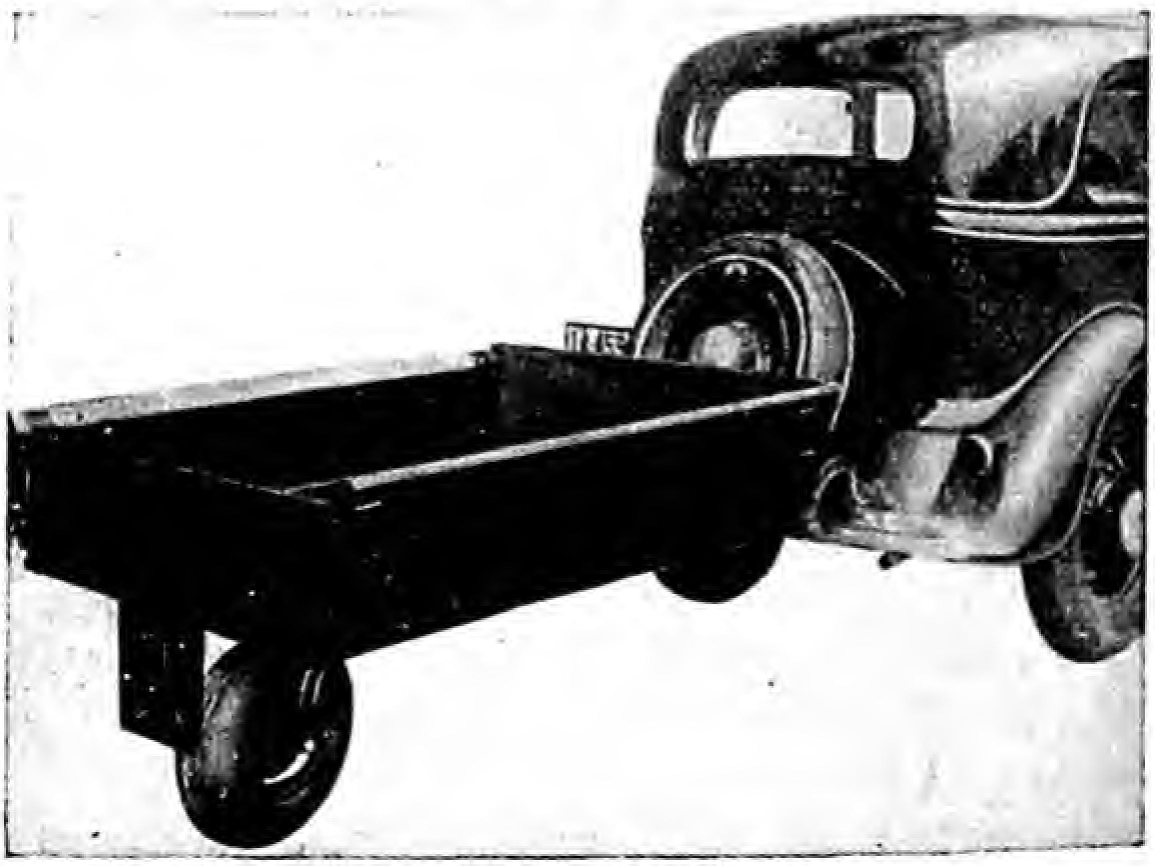


FIG. 700.—A one-wheel trailerette.

horizontal rigidity but vertical flexibility for uneven surfaces. The single wheel under the trailer swivels and permits the car and trailer to be parked, backed, and turned without attention to the trailer.

565. The Two-wheel Trailer.—Two-wheel trailers suitable for farm use are shown in Figs. 701, 702, and 703. The local blacksmith makes

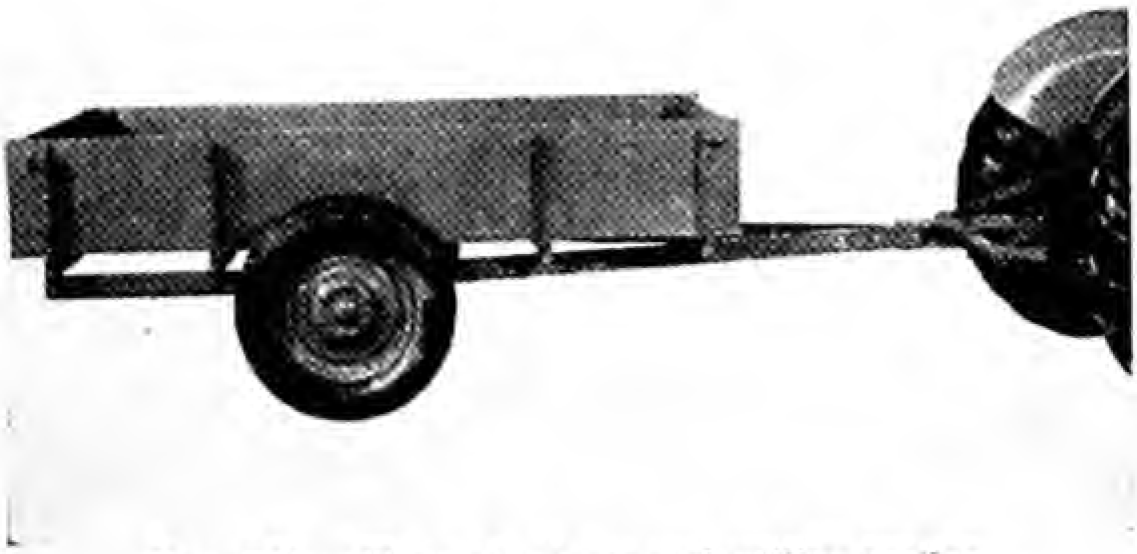


Fig. 701.—Two-wheel general utility trailer.

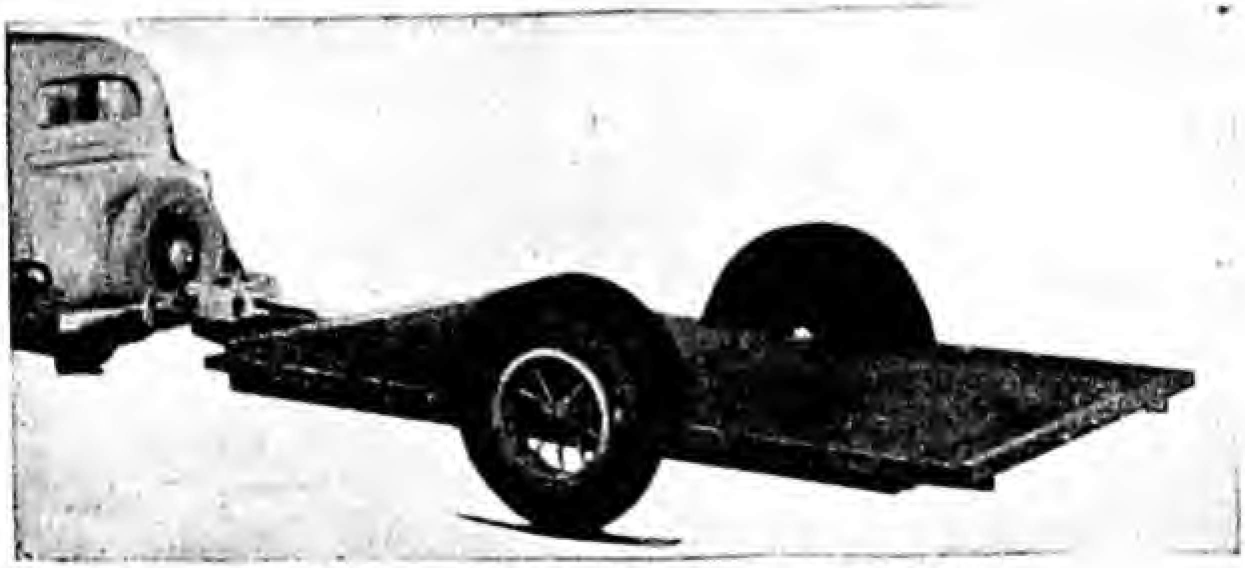


Fig. 702.—Low-platform two-wheel trailer.

Fig. 703.—Two-wheel trailer transporting a horse.

small trailers of this type out of discarded automobile chassis at a low cost. They can, however, be purchased from commercial concerns. The trailer shown in Fig. 703 is equipped with high sides for transporting horses, cattle, and other livestock. A low platform trailer is

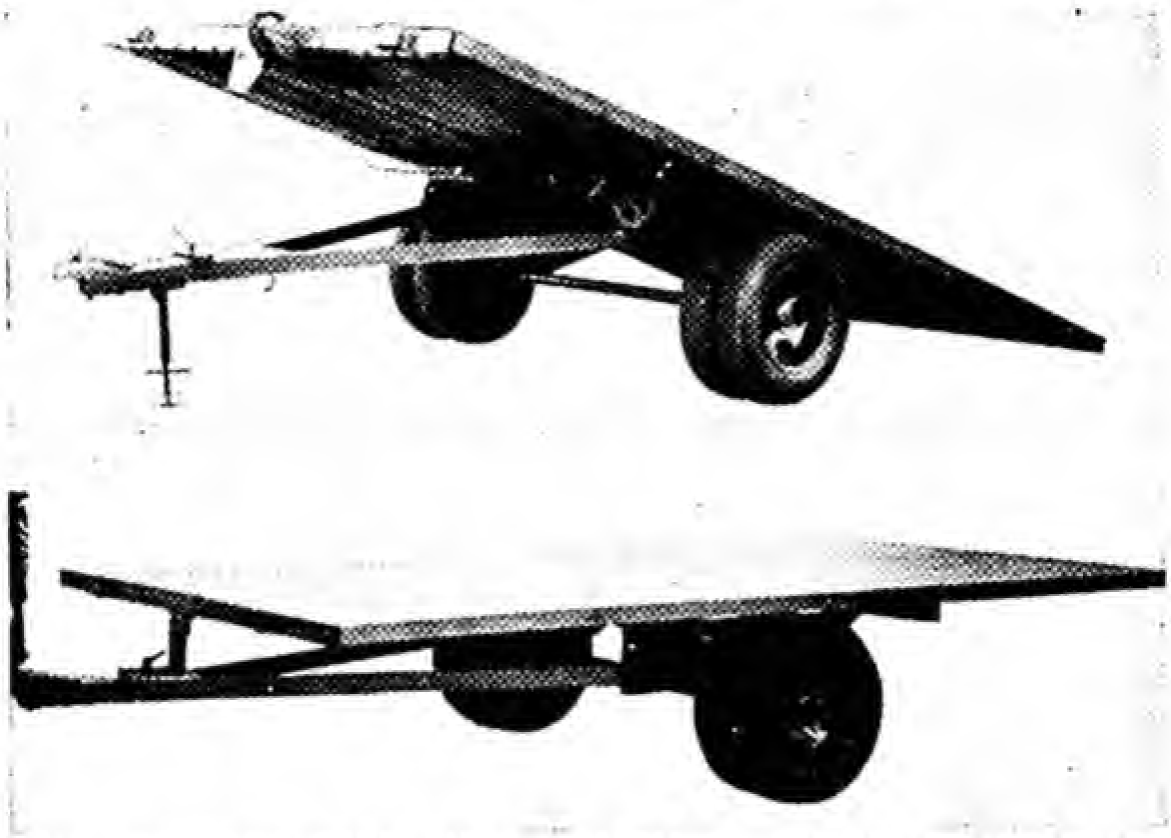


FIG. 704.—Trailer equipped with tilting platform, which is handy for hauling farm products and machinery.

shown in Fig. 704 suitable for hauling a tractor behind a light ½-ton pickup truck. Figure 705 shows a trailer box for a tractor.

When the two-wheel trailer is properly hitched, there is no tendency for it to whip, and moderately rapid speeds can be maintained with this type.

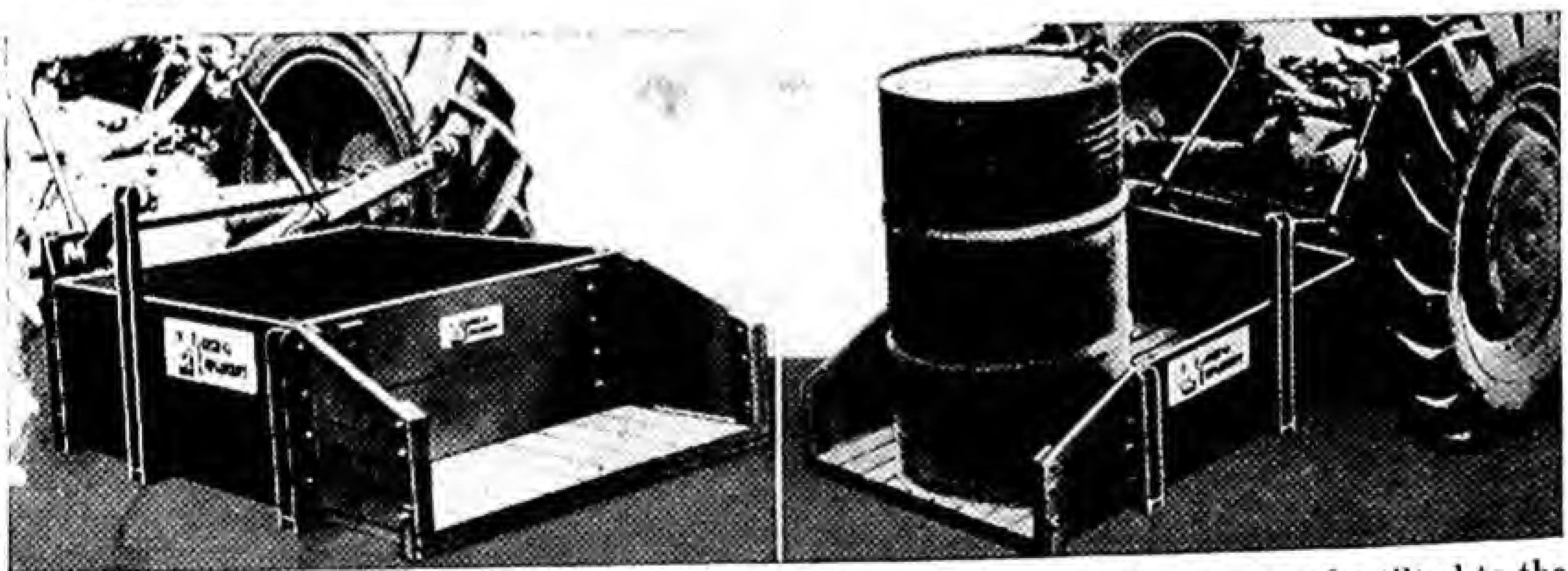


FIG. 705.—A trailer box attached to tractor. The rear end of the box can be tilted to the ground so that heavy drums of oil or fuel can be easily loaded and unloaded.

566. The Four-wheel Trailer.—Figures 687 and 688 show commercially built four-wheel trailer wagons, which can be used with an automobile, truck, or tractor, and with teams by substituting a pole for the trailer hitch. The wheels are equipped with roller bearings, demountable rims, and pressure fittings for good lubrication. A rigid construction prevents whipping.

567. Two-wheel Trailer Hitches.—Numerous methods have been used for hitching trailers; some of them are good, but others are poor makeshifts and dangerous for high speeds and rough conditions.

The ball-and-socket connection shown in Fig. 706 is considered an excellent hitch. It is easily attached and detached. The sleeve just back of the ball is under spring pressure and can be drawn back to permit one side of the socket to swing out on a hinge, releasing the socket from the ball. The ball-and-socket connection gives flexibility in all directions, but at the same time it maintains rigidity and prevents whipping of the trailer. The hitch shown in Fig. 707 is equipped with an automatic breaking device. When brakes are applied on the car the trailer pushes forward on the hitch and automatically applies the brakes on the trailer without attention from the driver.

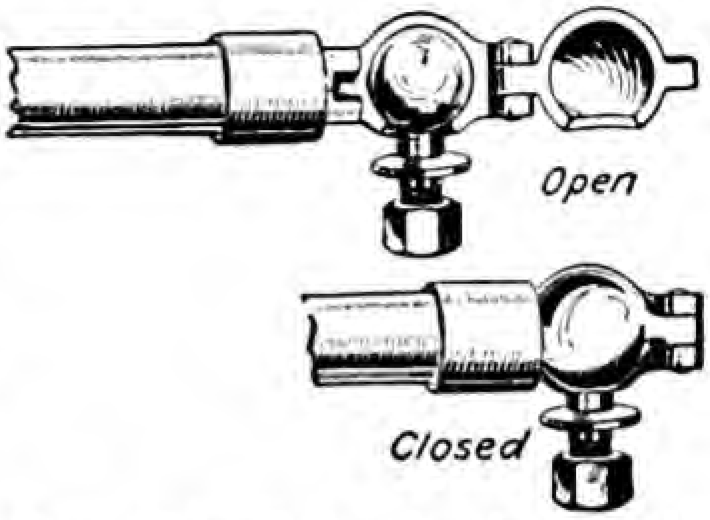


Fig. 706.—Ball-and-socket trailer hitch.

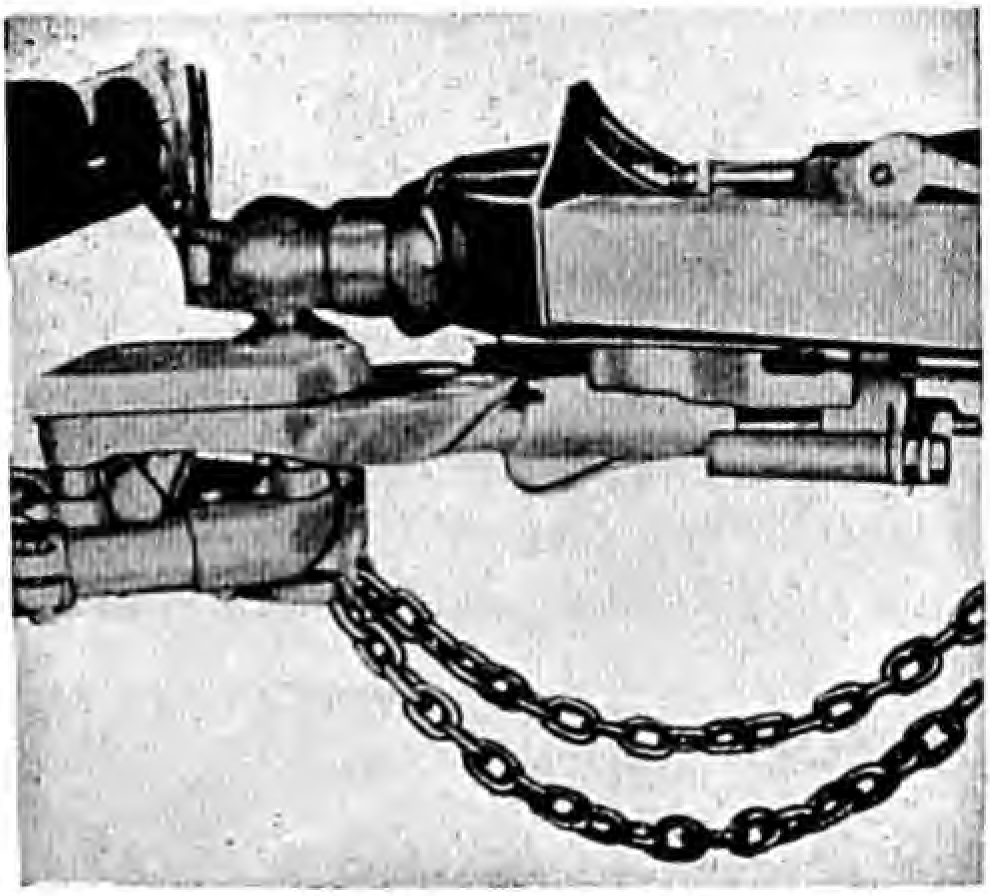


Fig. 707.—Trailer hitch equipped with automatic brake.

568. Four-wheel Trailer Hitches.—The hitch for a four-wheel trailer should be constructed out of strong material well braced and fastened rigidly to the vehicle. To prevent whipping, the tie rod must be held rigid; there should be no looseness in the other connections of the steering mechanism. The front wheels must be properly adjusted for toe-in and camber.

PART XIII
CLEANING AND GRADING MACHINERY

CHAPTER XXXII

CLEANERS, GRADERS, AND SEED TREATERS

The importance of cleaning grain before marketing and cleaning and grading seed before planting is being recognized by grain growers more and more every year. The selection of good seed is an essential step in the production of any crop. Certified seed breeders practice cleaning and grading of the seed they plant and sell.

Black[1] states that in 1923 the average wheat dockage of North Dakota was 11.3 per cent, and that over 15 per cent of the flax crop was dockage; that North Dakota produced over 9,000 carloads of dockage that year.

The Federal Grain Standards define dockage for wheat as sand, weed seed, weed stems, chaff, straw, grain other than wheat, and any other foreign material which can be removed readily from the wheat by the use of appropriate sieves, cleaning devices, or other practical means suited to separate the foreign material present.

569. Types of Cleaner.—There are several types of grain-cleaning machines. Some types are suited for use in elevators or large granaries; other types are adaptable for farm use.

In general, grain cleaners and grain graders clean and grade the seed according to

1. The size of the seed.
2. The shape of the seed.
3. The specific gravity of the seed.
4. The combinations of either size, shape, or weight of the seed.

The actual separation is accomplished by means of sieves and air, by cylinders, and by pockets in the sides of discs or belts. The cleaners using sieves and air methods of separation are termed *fanning mills.*

570. Fanning Mills.—Fanning mills are made in sizes suitable for use in elevators and on farms. Figure 708 shows a cross-sectional view of a mill used in elevators, while Fig. 709 shows a cross section of a small farm fanning mill.

[1] *Agr. Eng.*, Vol. 6, No. 8, p. 180, 1925.

The grain to be cleaned is poured into a hopper on top of the mill, from which it is fed onto the sieves or screens. These sieves are shaken either sidewise or endwise. In the side-shake mill, the movement of the sieves is at right angles to the flow of grain, while in the end-shake type, the movement is parallel to the flow of the grain.

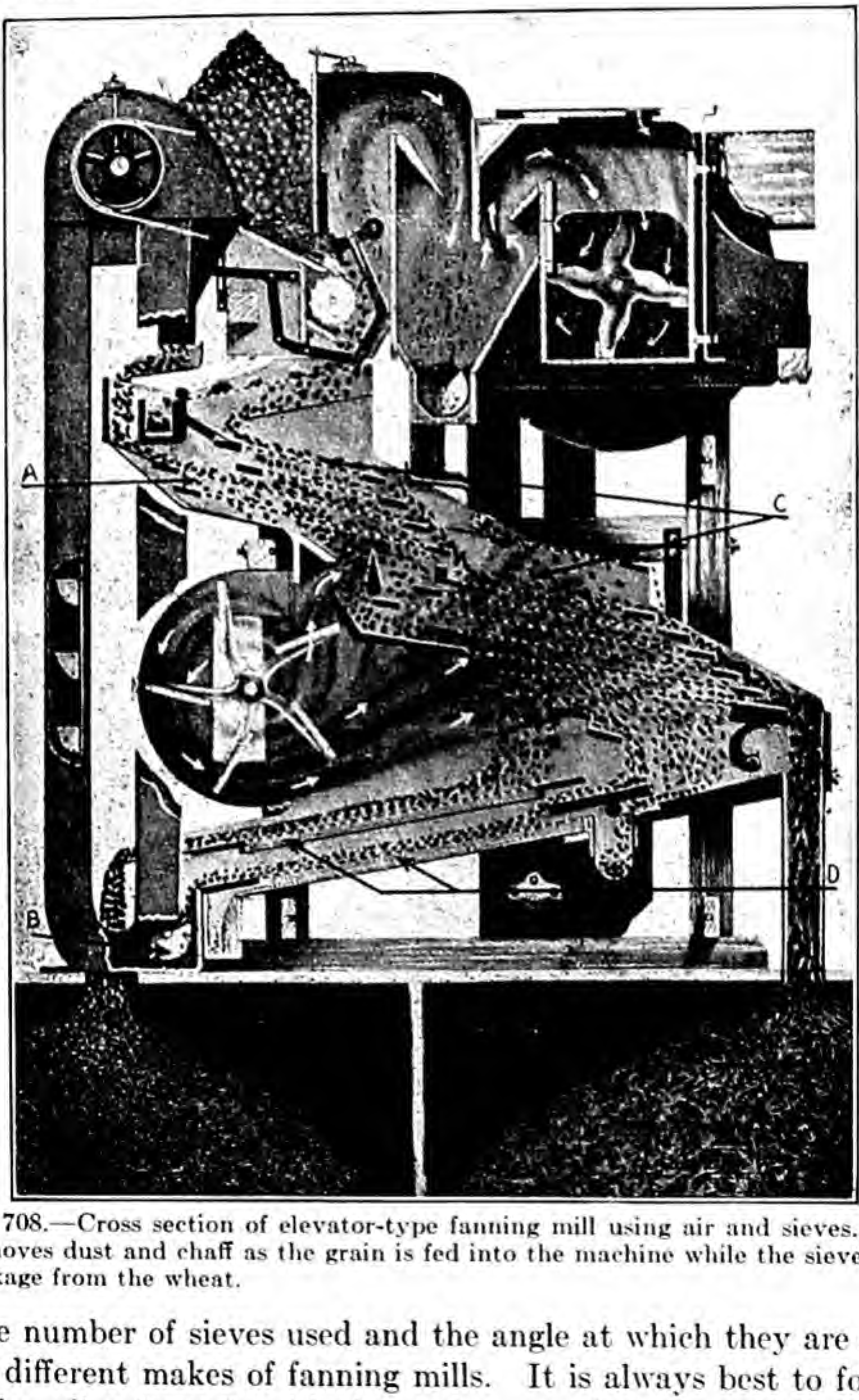


FIG. 708.—Cross section of elevator-type fanning mill using air and sieves. Air suction removes dust and chaff as the grain is fed into the machine while the sieves separate the dockage from the wheat.

The number of sieves used and the angle at which they are set vary in the different makes of fanning mills. It is always best to follow the operating directions furnished by the manufacturer. Different types of perforated sieves and screens can be placed in the machine to clean and grade different kinds of seed.

The fan should furnish a blast of air of sufficient volume and velocity to remove dust, pieces of straw, and light, immature, and diseased seed. The blast can be regulated by the wind boards on each end of the fan-case housing.

In fanning mills the blast may operate through, above, under, parallel to, or at right angles to the sieve and grain.

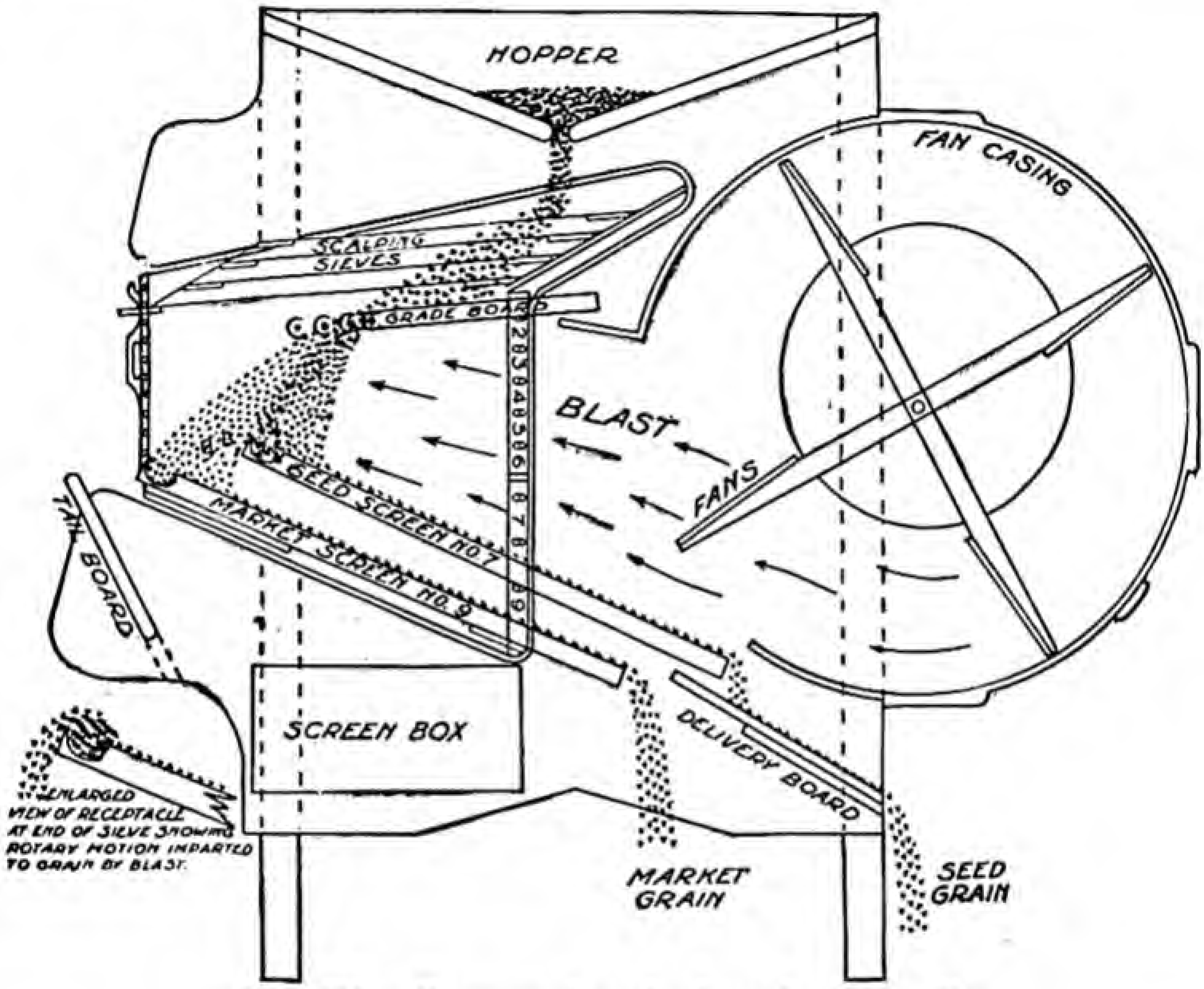


FIG. 709.—Cross section of a farm fanning mill.

571. Oat Kickers.—The machine shown in Fig. 710 is commonly called an *oat kicker*. It differs from the fanning mill in that the sieves are placed at a steep angle and are similar in construction to the chaffer of a thresher. The wheat kernels pass through the angle in the throat of the sieve, while the oats, being too long to pass through this angle, are kicked backward in the direction of the throw of the sieve or riddle and are finally discharged from the machine. The wheat kernels and fine seeds fall through the sieves on a screen below, where the fine seeds are screened from the wheat.

572. Disc Cleaner and Grader.—The disc type of cleaner, as shown in Fig. 712, is also called a *pocket* cleaner, because sieves of pocketed vertical discs are used as the separating mechanism. In cleaning wheat, the weed seed that are shorter than the wheat kernels fall into and remain in the pockets. Then, as the disc passes upward through the grain and the weed seed the latter are carried out of the grain and discharged into a

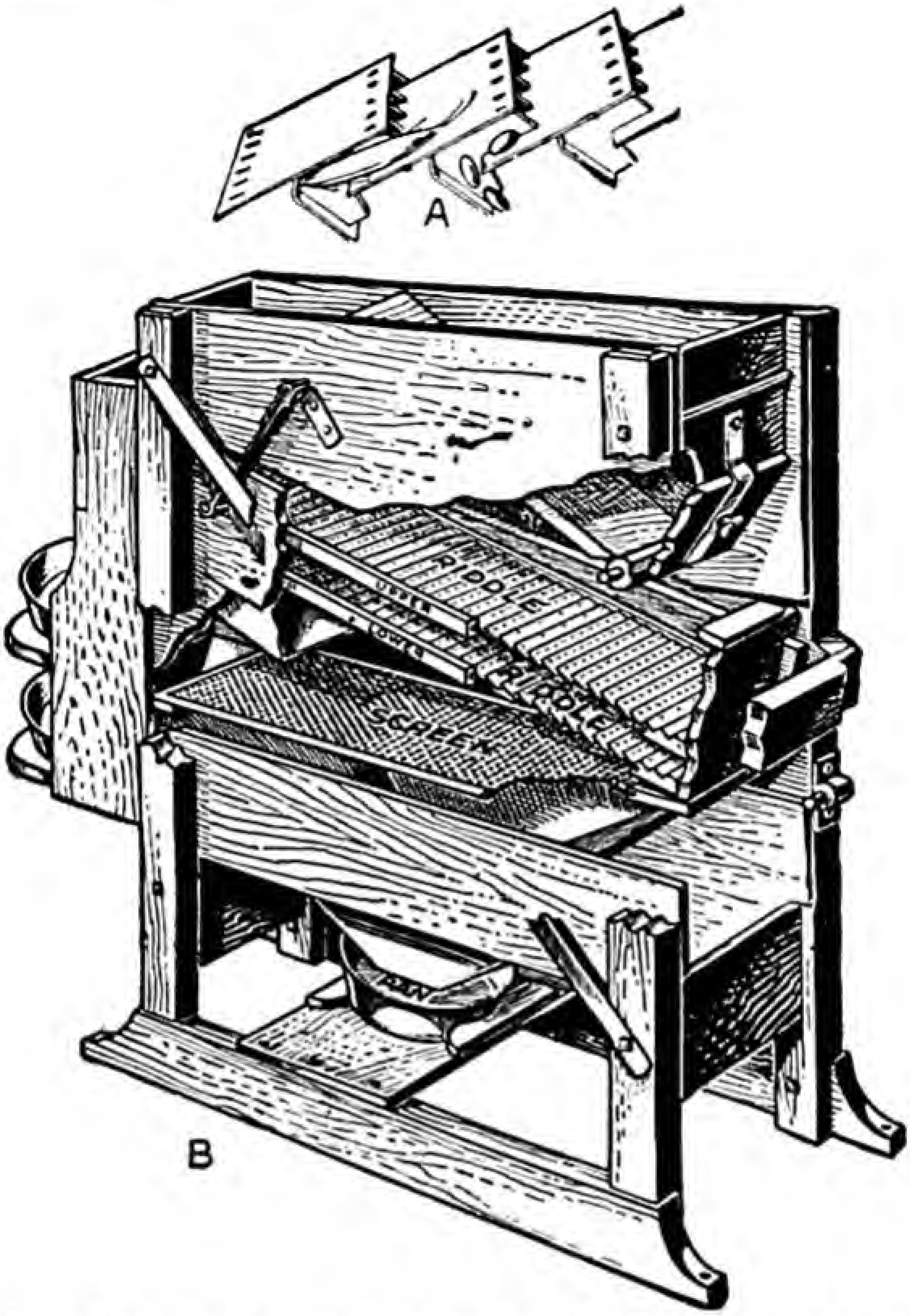


FIG. 710.—Wild-oat kicker: *A*, section of sieve or riddle; *B*, cross section of machine (*U. S. Dept. Agr. Bull.* 1542).

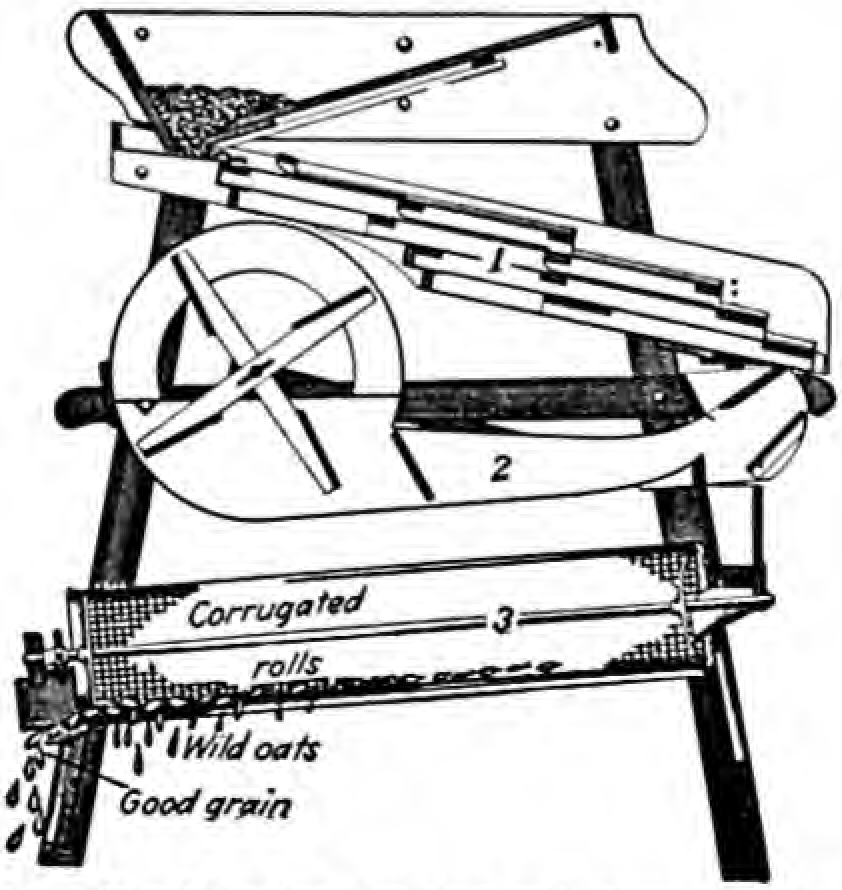


FIG. 711.—Combination fanning-mill cleaner and grader.

trough or hopper. Since the wheat kernels and wild oats are too long to remain in the pockets, they are moved to another part of the machine

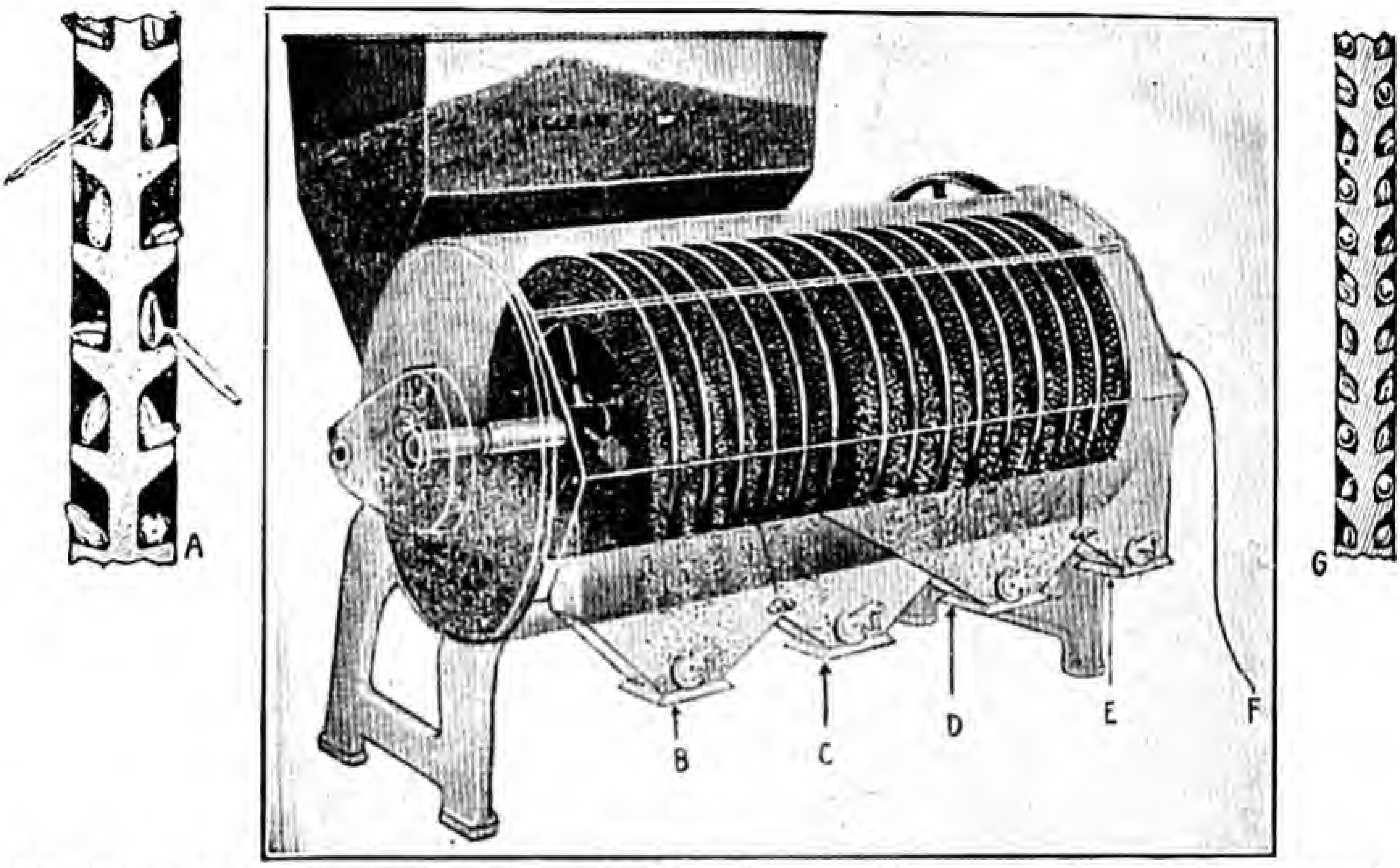


Fig. 712.—Sectional views of farm-size disc cleaner with cross sections of the discs used.

in which the pockets are large enough to remove the wheat kernels from the wild oats (Fig. 712).

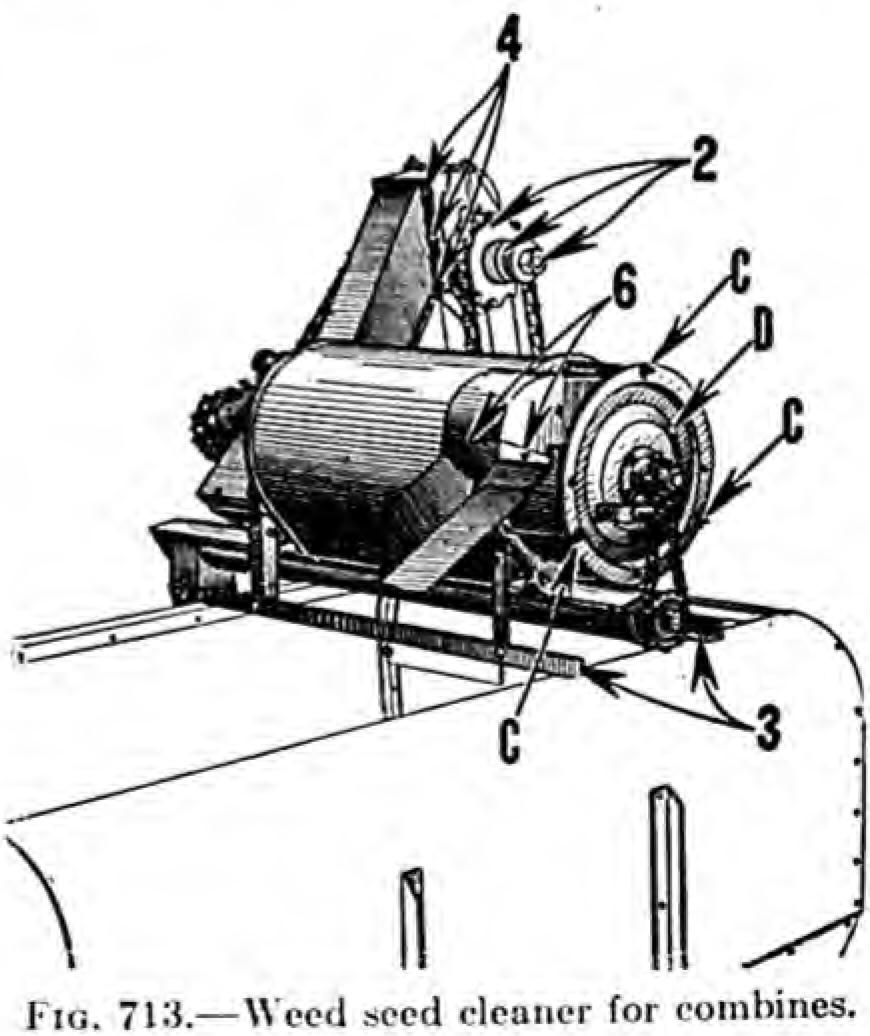


Fig. 713.—Weed seed cleaner for combines.

Cleaners are built in sizes suitable for use with threshing machines, on combines (Fig. 713), in farm granaries, and in small elevators.

573. Gravity Separator.—The spiral gravity separator (Fig. 714) utilizes both the difference in shape of the seed and the difference in weight. As a stream of seed flows down the flat spiral incline, the heavier seed move faster, swing to the outside of the chute, and are separated from the lighter seed.

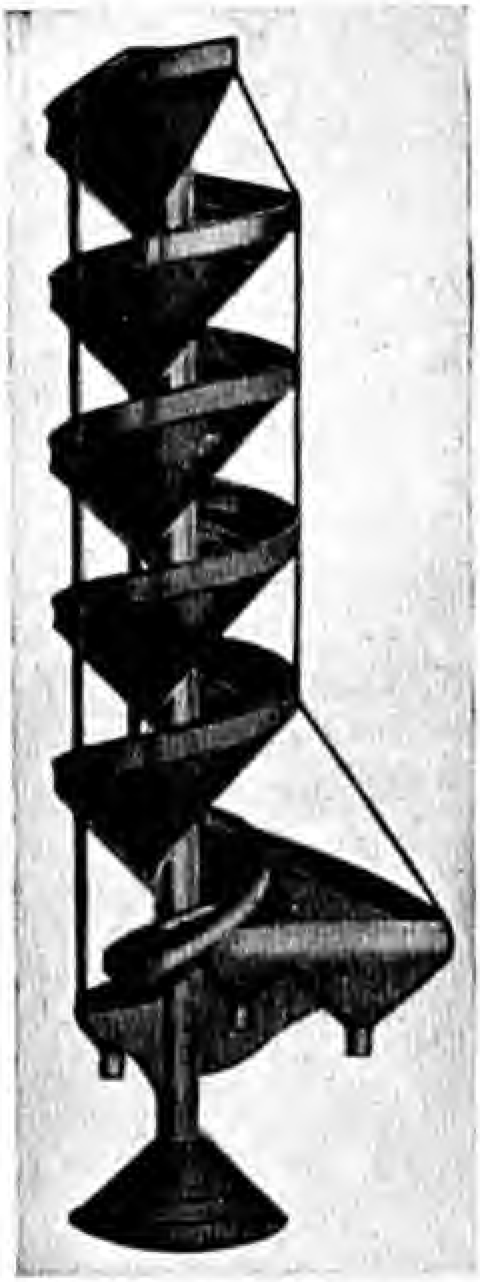


FIG. 714.—Spiral gravity separator.

CYLINDER CLEANERS AND GRADERS

574. For Wheat.—The cylinder cleaner and grader, as shown in Fig. 715, operates on the same general principle as the disc cleaner. Instead of pockets on the sides of discs, however, there are indented pockets on the inside circumference of the cylinder (Fig. 716).

The wheat and small seed are caught in the pockets, carried upward out of the oats, dropped into a conveyor trough, and conveyed separately out of the cylinder. Further separation of weed seed and wheat is accomplished in another cylinder having pockets of suitable size (Fig. 716). The size and capacity of the machine are determined by the number of cylinders used.

575. For Corn.—A small inexpensive cylinder corn grader is shown in Fig. 717. It consists of a single or double cylinder with sections having different-sized holes to allow kernels of different size to pass through. One end of the cylinder is lower than the other, which causes the kernels

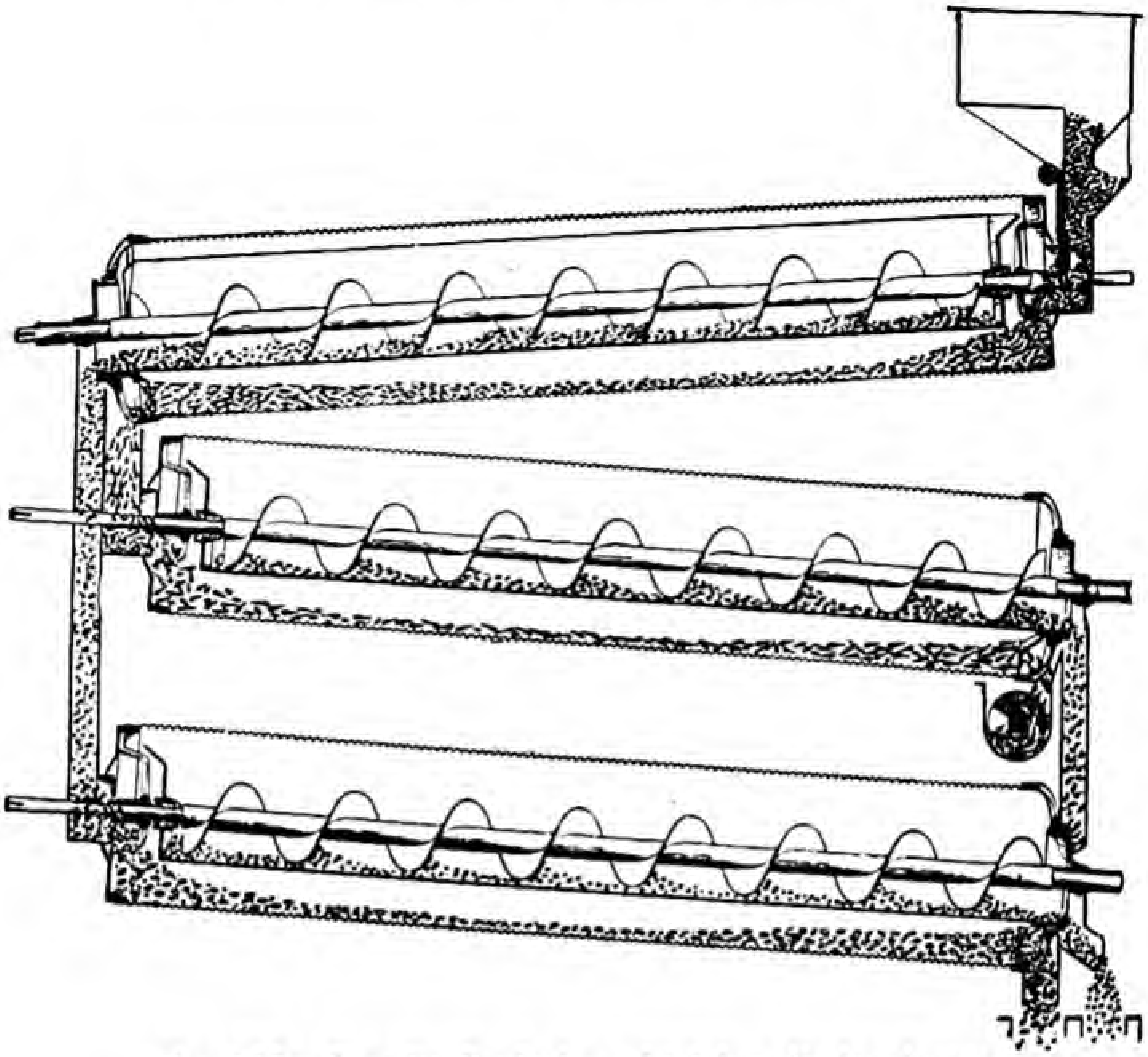


FIG. 715.—Longitudinal view of triple-cylinder cleaner.

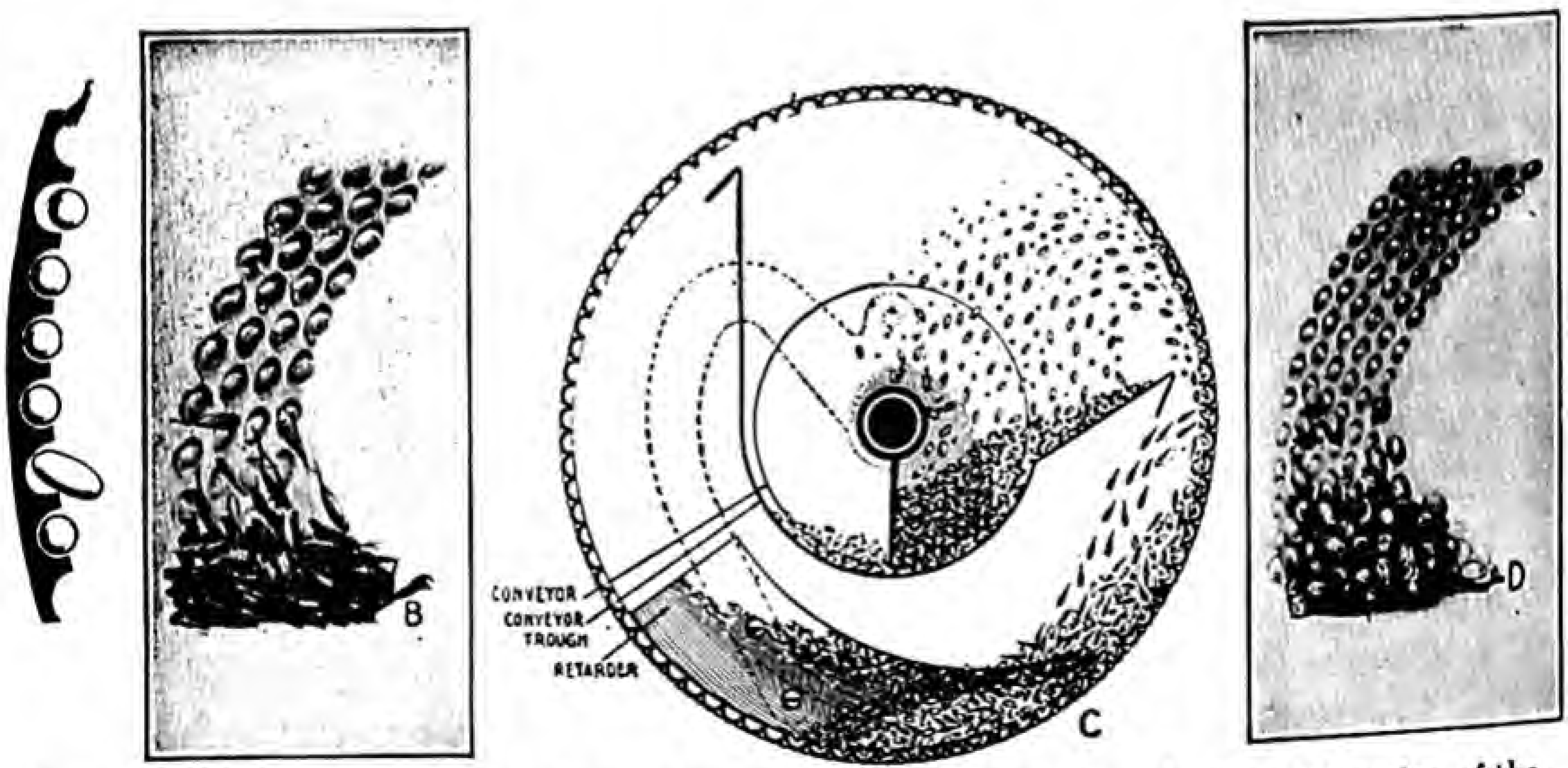


FIG. 716.—Cross section of cylinder cleaner with enlarged sections showing the action of the pockets.

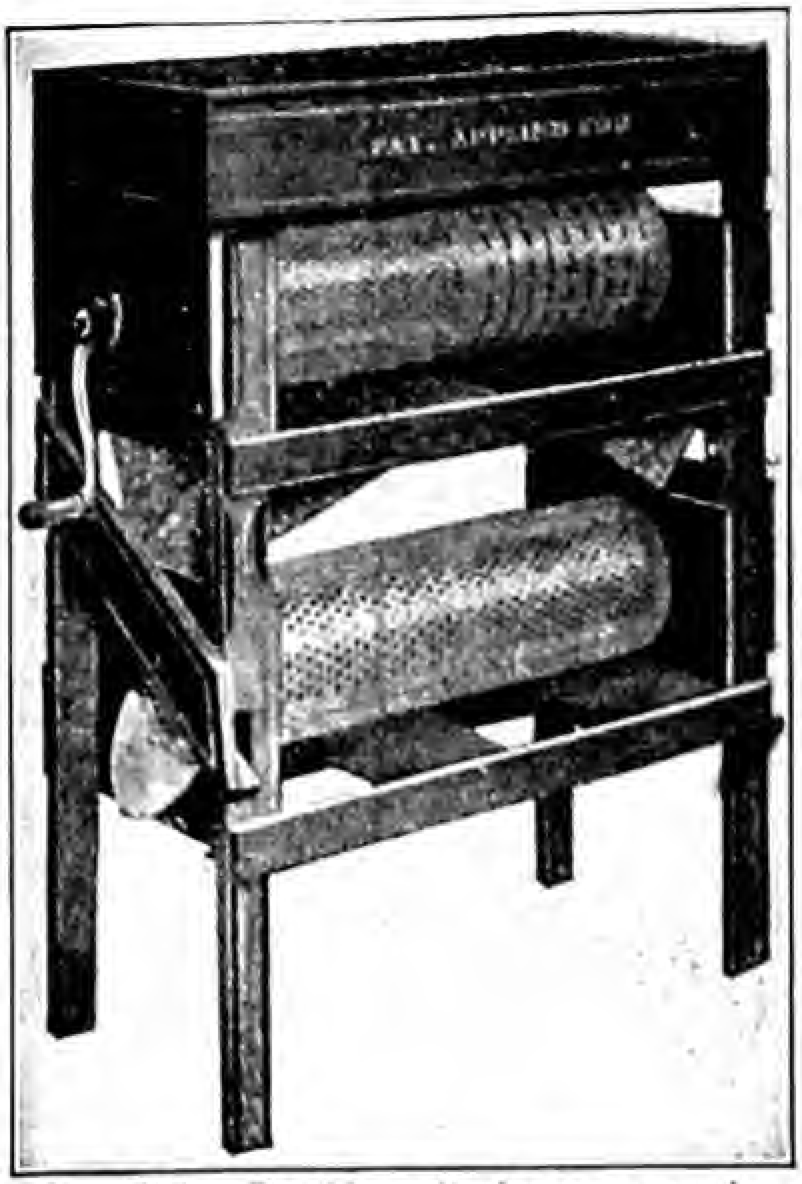


FIG. 717.—Double-cylinder corn grader.

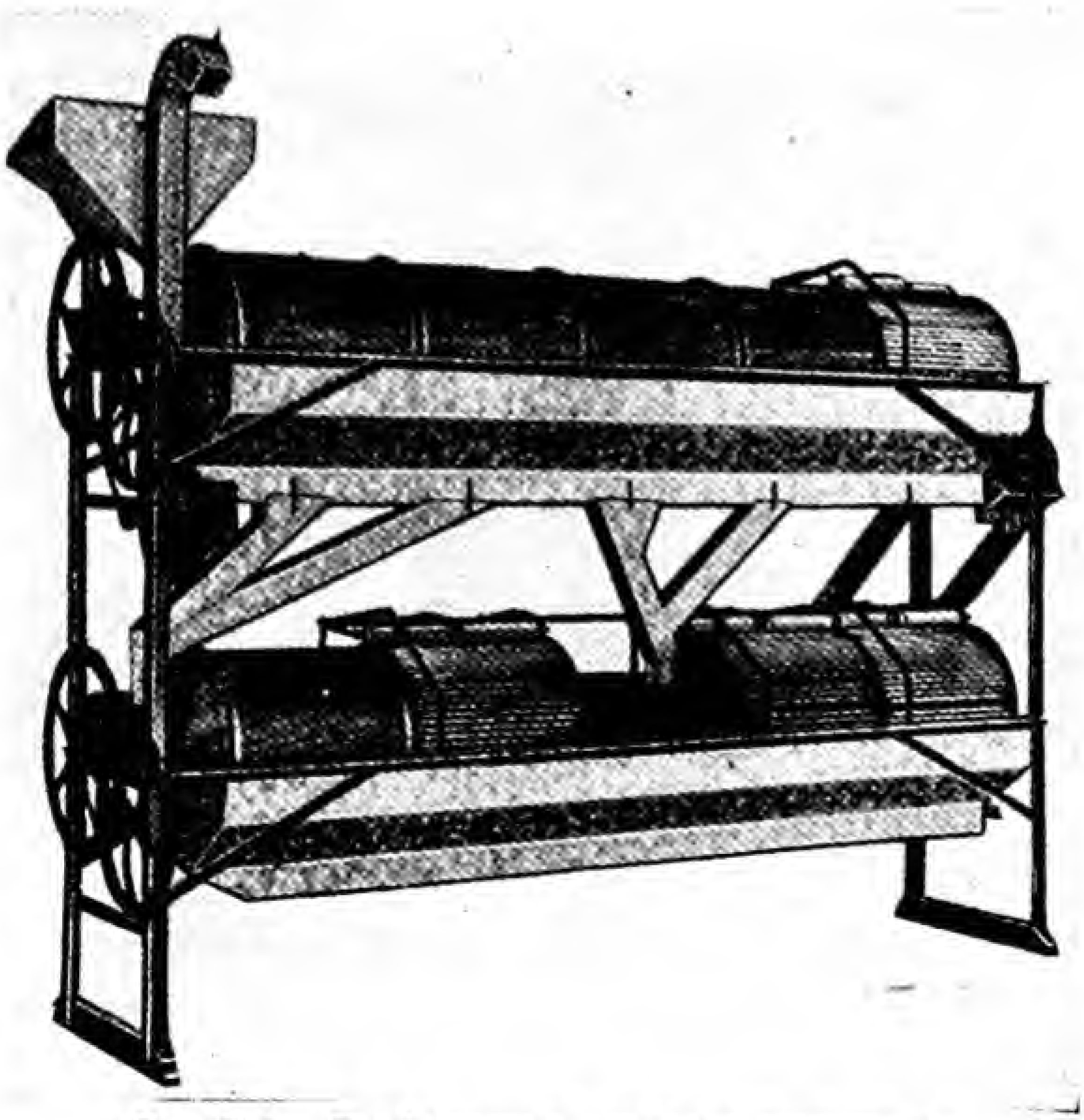


FIG. 718.—Double-section cylinder corn grader.

to move along inside the cylinder until they come to the section having the proper size outlet.

576. For Cotton.—Cylinder graders are also used to grade cottonseed (Fig. 719). The cylinder is constructed, as in the case of the corn grader,

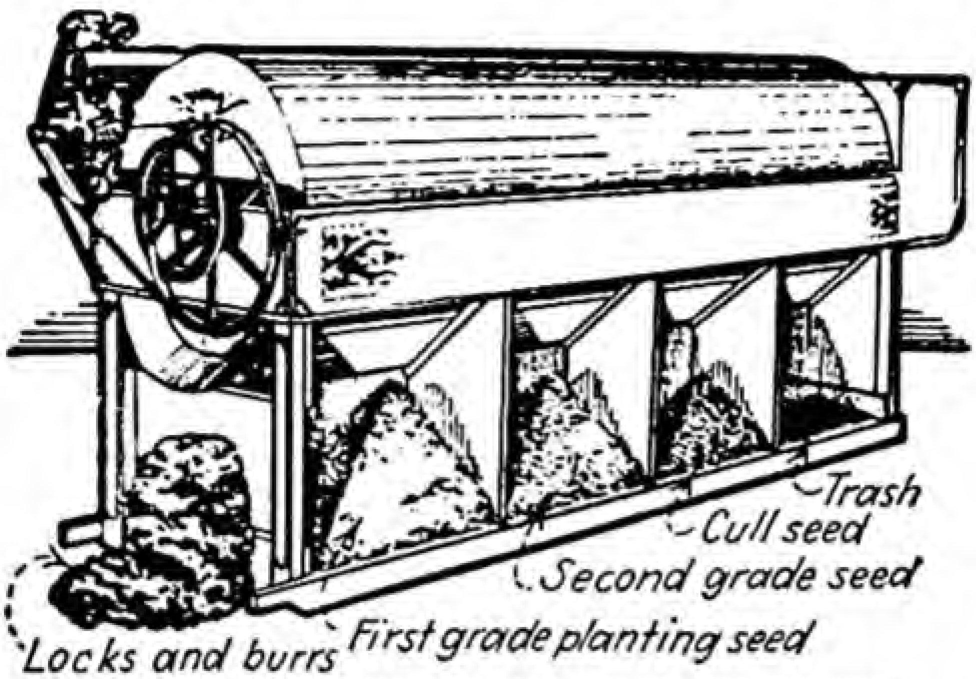


FIG. 719.—Cylinder cleaner for cottonseed.

with sections having different-sized holes. In general, the action is similar to that of a sieve, but instead of a vibrating action there is a revolving movement to agitate the seed.

577. For Peanuts.—Figure 720 shows a cylinder constructed to grade peanuts.

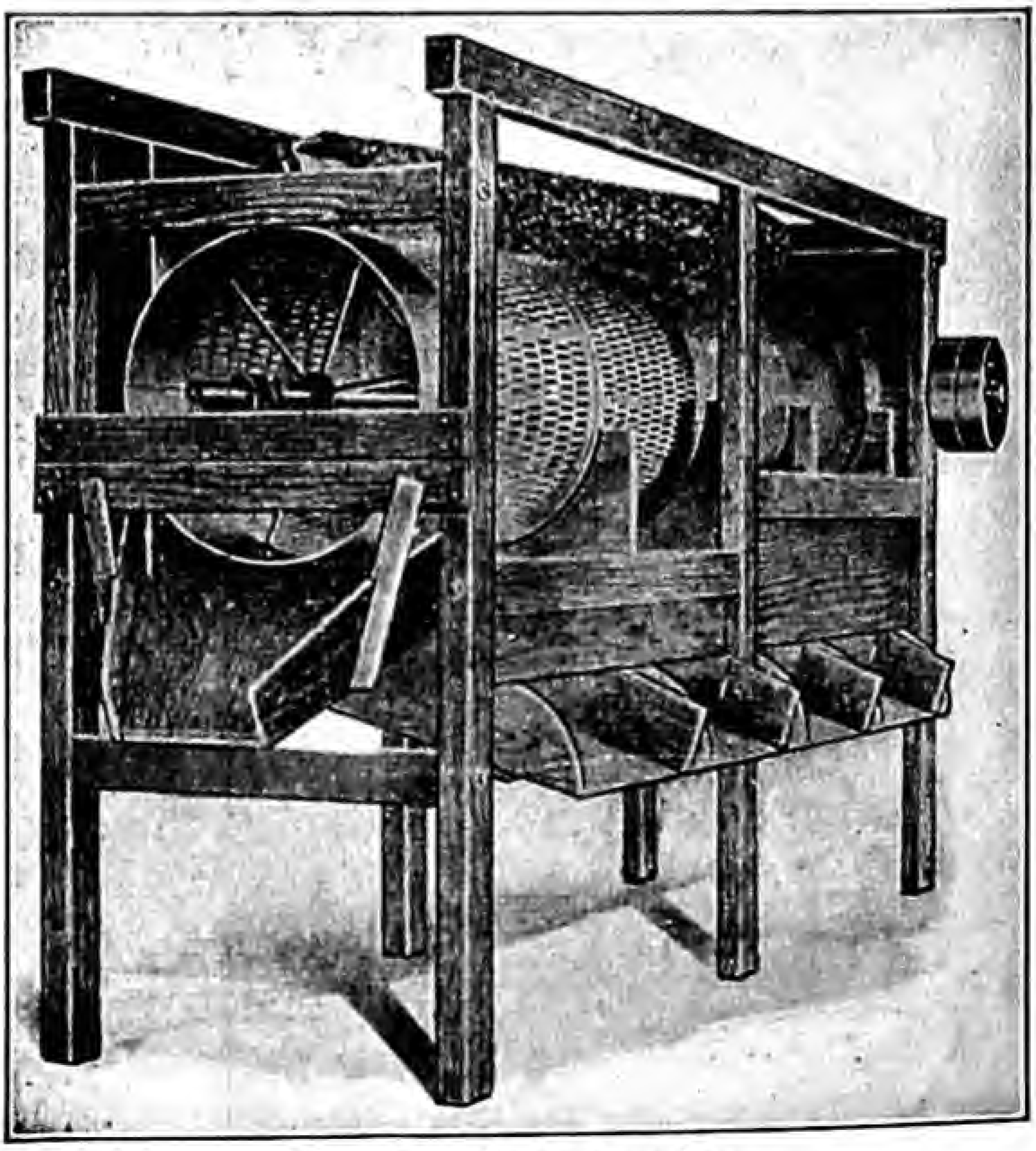


FIG. 720.—Peanut grader.

578. Belt Separator.—The belt separator shown in Fig. 721 separates round from unround seed by means of an endless up-travel belt, the pitch of which can be changed. As the belt travels upward, the round seed

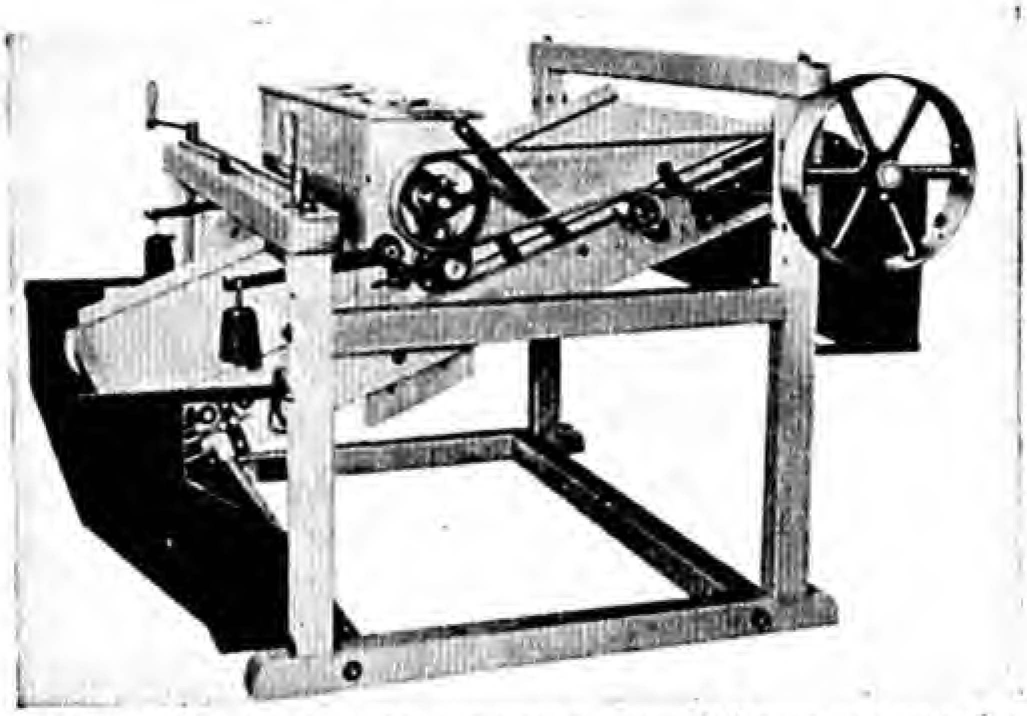


Fig. 721.—Belt cleaner to separate round from unround seed.

roll down and off the lower side, and the unround seed are carried up and over the upper side and discharged into a hopper.

FRUIT GRADERS AND CLEANERS

Fruit growers are giving more attention to grading their product before placing it on the market. Some fruits must be handled more or less gently to prevent bruising. Figure 722 shows a grader which uses

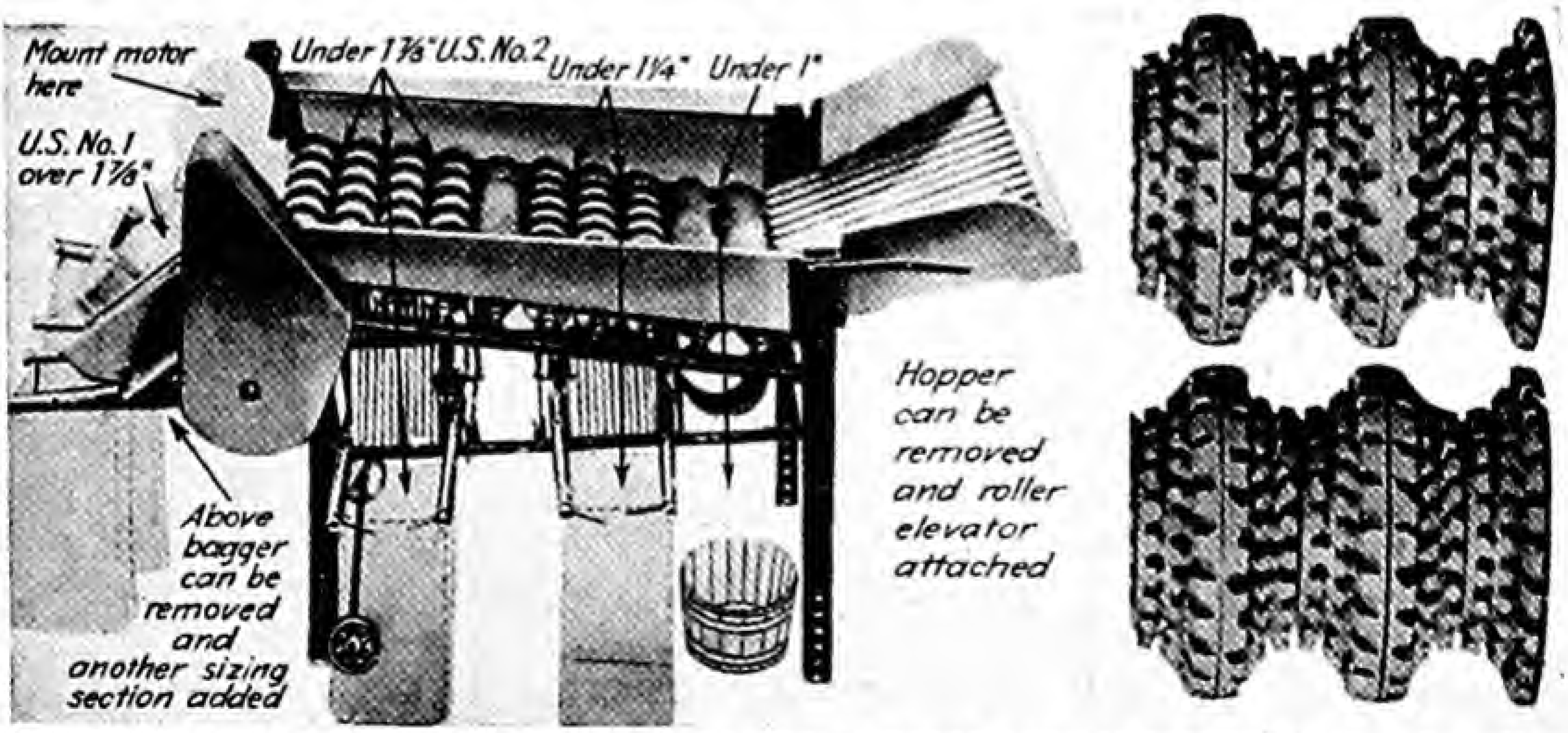


Fig. 722.—Grader which uses revolving rubber sizing spools and cleaning rollers. A section of the sizing spools is shown on right.

revolving rubber sizing spools and cleaning rollers. Figure 723 shows a special fruit and vegetable cleaner and polisher. Small rubber brushes are used underneath while cloth buffers are used above. A fan sucks away the dirt and trash.

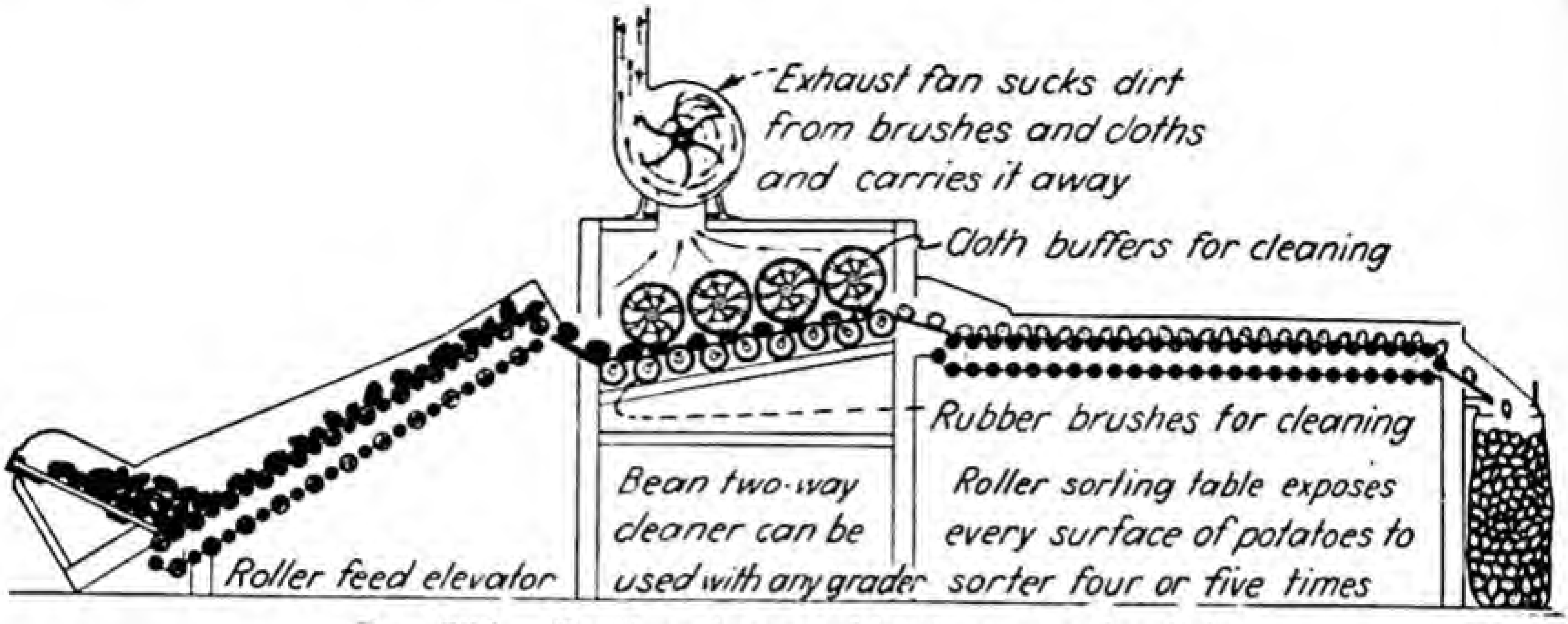


FIG. 723.—Fruit and vegetable cleaner and polisher.

BEAN PICKERS

Figure 724 shows a bean picker equipped with a double hopper and a double set of revolving rollers, which pick out the trash, dirt, and broken

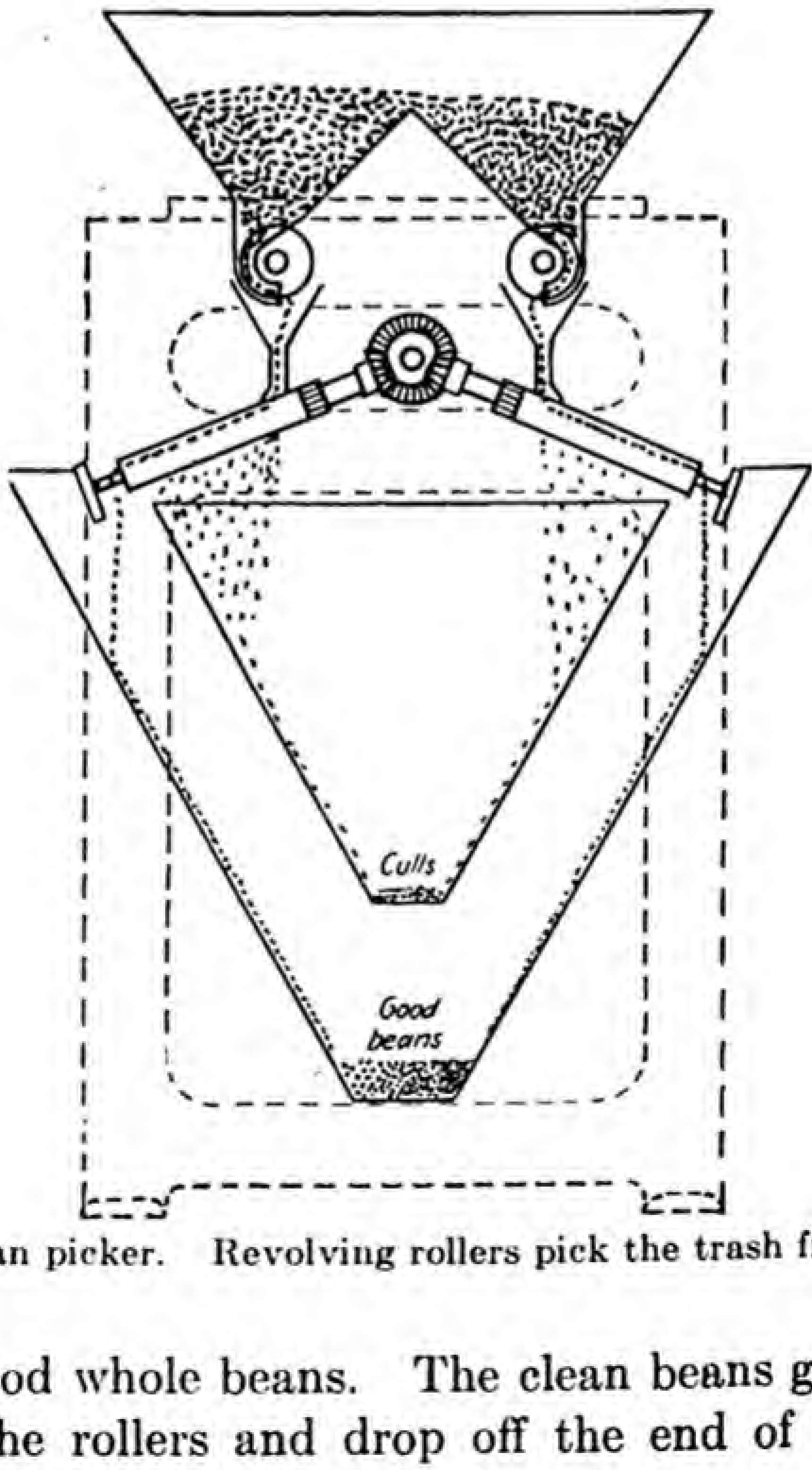


FIG. 724.—Bean picker. Revolving rollers pick the trash from the beans.

beans from the good whole beans. The clean beans gravitate down the trough between the rollers and drop off the end of the rollers into a hopper.

SEED TREATERS

Farmers are using chemical dusts to treat the planting seed for many different crops in an effort to obtain a high percentage of good healthy plants. Several makes of machines are available. The design differs

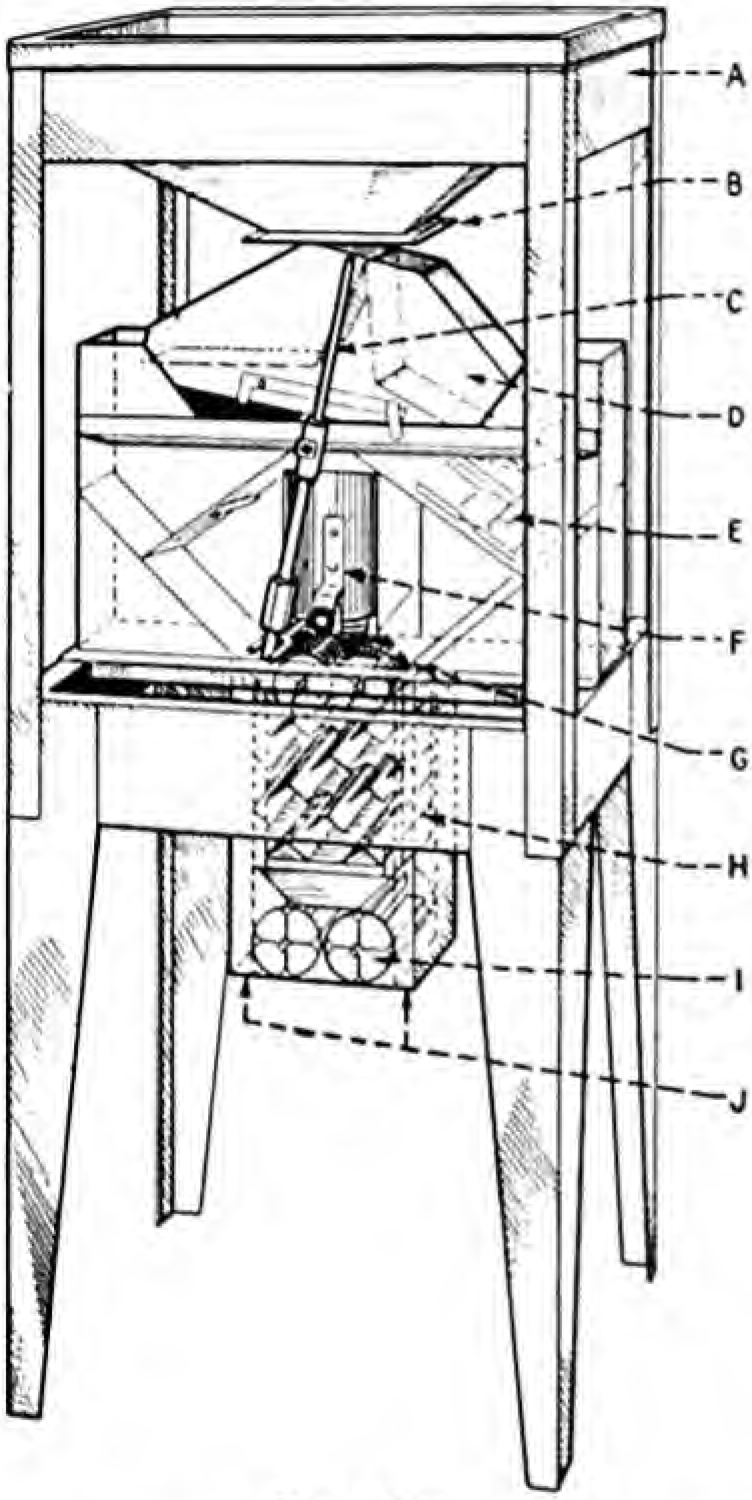


FIG. 725*a*.

FIG. 725*b*.

FIG. 725*a*.—A seed treater for small grain: *A*, hopper capacity approximately 1 bushel; *B*, opening adjustable by quick-acting slide; *C*, counterweight adjustable for different types of grain; *D*, metering pan accurately measures grain to tilt 30 times per bushel; *E*, grain-flow control slides adjustable to prevent clogging; *F*, removable dust box with accurate adjustment—60 ejections of dust per bushel—no waste, dust ejected only when grain flows; *G*, atomizing spinners ensure perfect distribution of dust; *H*, larger mixing chamber with removable baffle core to facilitate thorough cleaning of machine; *I*, distributing outlet spinners increase mixing efficiency; *J*, ventilating shorts cause updrafts to return any free dust.

FIG. 725*b*.—Homemade grasshopper bait mixer can also be used to mix chemical dusts with undelinted cottonseed. (*U. S. Dept. Agr. Bur. Entom. and Plant Quarantine.*)

somewhat according to the kind of seed to be treated. Seed-treating machines should be equipped with a device to measure the quantity of chemical dust in proportion to the quantity of seed being treated. Figure 725*a* shows a seed treater for small grain.

PART XIV

SOIL- AND WATER-CONSERVATION MACHINERY

CHAPTER XXXIII

TERRACING MACHINERY

The world, and especially the United States, is becoming conscious of the tremendous soil and water losses from agricultural lands. Of the many methods used to combat these losses, terracing is one of the foremost. Consequently, machinery for building and maintaining terraces is becoming an essential farm tool. Terracing machines range in size from the small walking plow that may be drawn by one or two mules to the large road-building machine drawn by a 60-horsepower tractor. Between these extremes are the V-drags and ditchers, both homemade and commercial types; ditcher-graders of many sizes; elevating graders; and a number of special machines. A successful terracing machine must be adaptable to work efficiently in all soil types, on gradual and steep slopes, on smooth or gullied land, in small and large fields, in cultivated fields and in pastures, in stumpy and rocky fields, and in dry and wet soils.[1]

579. Plows.—A popular type of plow for the building of terraces is the walking moldboard plow equipped with a long grader bladelike mold-

FIG. 726.—Terracing plow.

board (Fig. 726). These plows are suitable for building low terraces on moderate slopes. The time and labor required to build terraces with such small equipment are excessive.[2]

[1] *Agr. Eng.*, Vol. 16, No. 1, pp. 3 and 5, 1935.

[2] *Agr. Eng.*, Vol. 16, No. 1, p. 3, 1935.

Disk plows may be used to build terrace ridges, but they do not move soil so great a horizontal distance as do moldboard plows. They are also awkward to handle when used on a ridge.

580. Slip Scrapers.—Horse-drawn (Fig. 727) and tractor-mounted slip scrapers (Fig. 728) are used in making fills where the terrace crosses gullies.

FIG. 727.—Horse-drawn slip scraper.

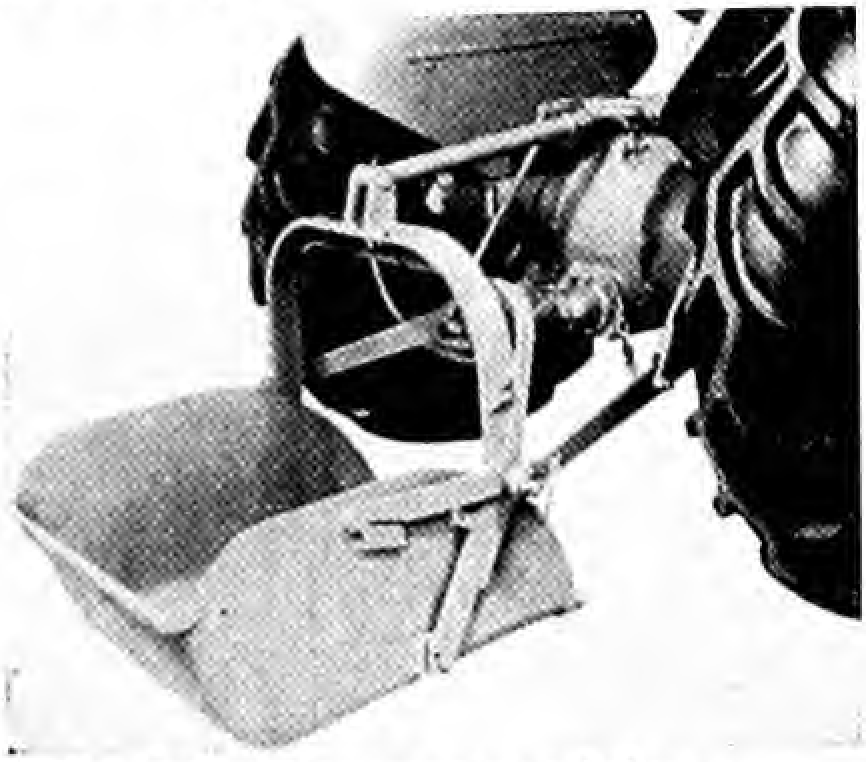


FIG. 728.—Tractor-mounted slip scraper.

581. Fresno.—The fresno is not only used in making fills but also for building the terrace. Both horse-drawn (Fig. 729) and tractor-

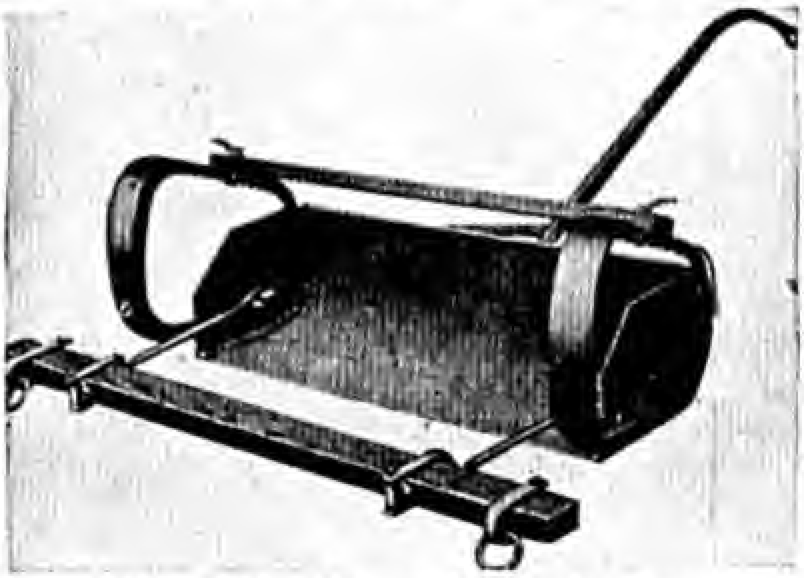


FIG. 729.—Horse-drawn fresno.

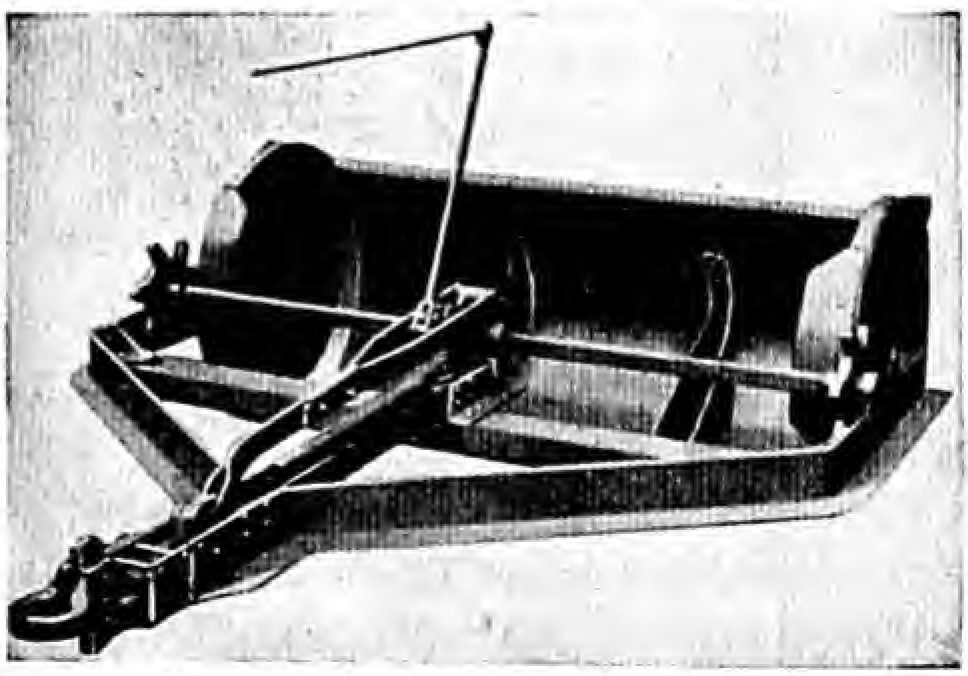


FIG. 730.—Tractor rotary fresno.

power-dump types (Fig. 730) are used. One objection to the fresno is that the surface soil for a considerable distance on each side of the

terrace is scraped off in building the terrace. Graders cut into and throw up much subsoil. A smooth terrace cannot be built with a fresno.

582. V-drags and Graders.—The wooden V-drag, when properly constructed, will move a considerable volume of loose soil several feet horizontally.

Steel V-type terracers are equipped with a lever and front-wheel assembly to raise and lower the front end (Fig. 731). An adjustable rolling coulter attached to the rear end of the landside gives lighter draft and holds the landside when a heavy load is carried on the blade. Extension bars push and smooth the soil beyond the end of the blade.

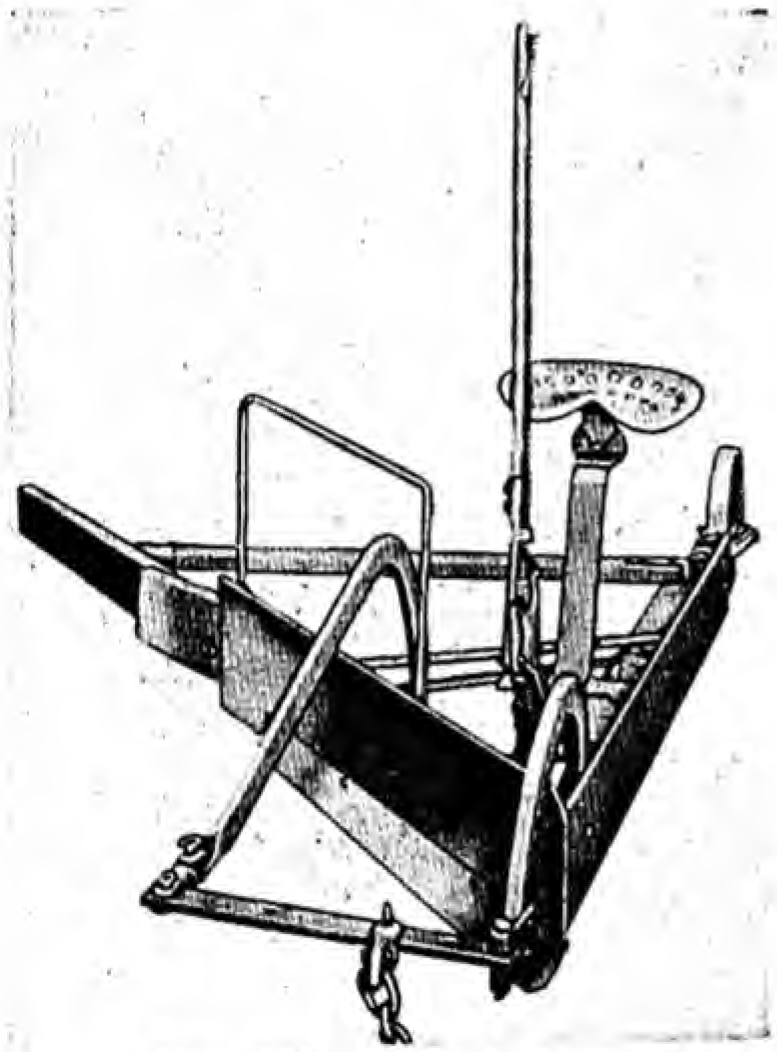


FIG. 731.—Steel V-drag.

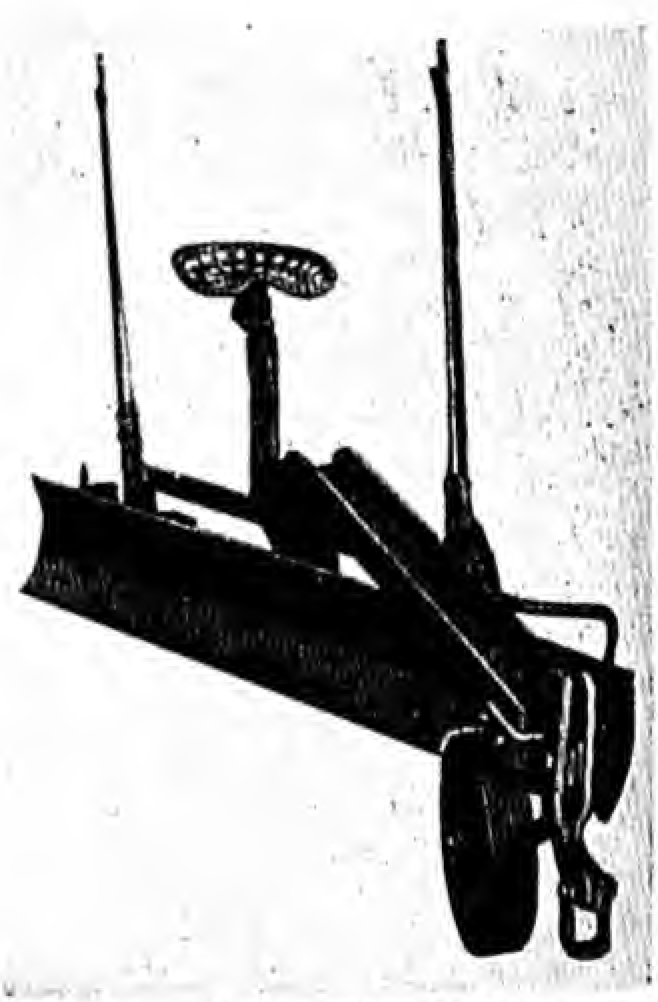


FIG. 732.—Three-wheel light terracer grader.

Construction costs with the steel V-type terracer are higher than when graders are used. Plowing to loosen the soil so the terracer can handle it is one factor that makes the cost higher.

583. Three-wheel or Light-terracing Grader.—These terracers are pulled by teams or farm tractors. When a small amount of power is available on the farm, terraces can be economically constructed with the small terrace graders.[1]

This type of terracing machine is composed of a grader blade 6 to 8 feet long suspended under a beam (Figs. 732 and 733). Two coulter-like wheels are attached to the rear of the blade to provide a means of raising and lowering and in firm soil as aids in overcoming side thrusts when loaded. A tongue truck supports the front end of the beam when

[1] *Agr. Eng.*, Vol. 16, No. 1, p. 3, 1935.

horses supply the power, but it is removed when the machine is drawn by a tractor. Provision is made for angling the blade both to the right and to the left.

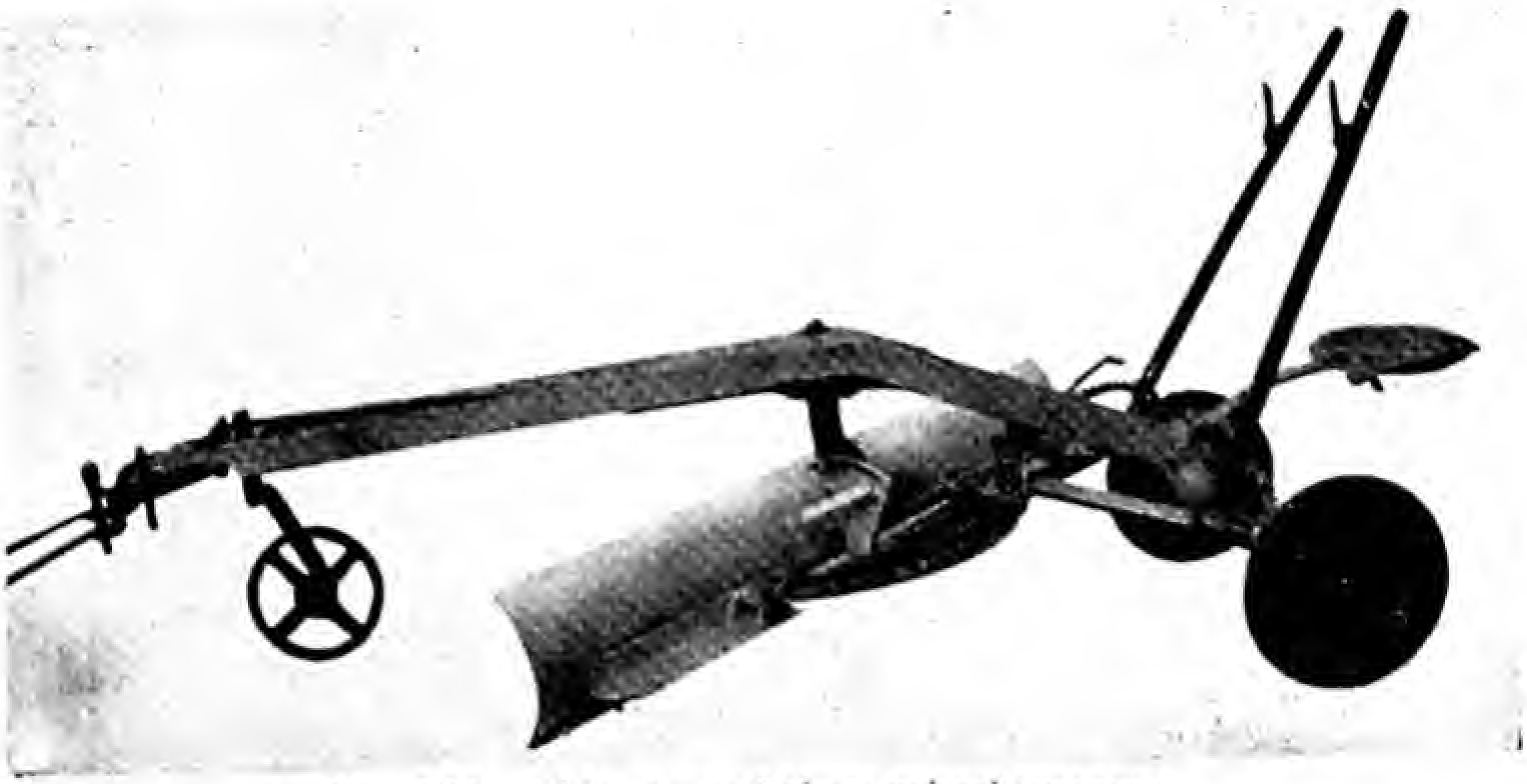


FIG. 733.—Side view of three-wheel terracer.

584. Two-wheel Terracer.—The two-wheel terracer is so called because the rear of the machine is supported and carried on two wheels (Fig. 734) and the front attaches directly to the tractor by some form of "gooseneck" hitch (Fig. 736). Figure 735 shows a two-wheel terracer equipped with a hydraulic lift. This arrangement permits short turns,

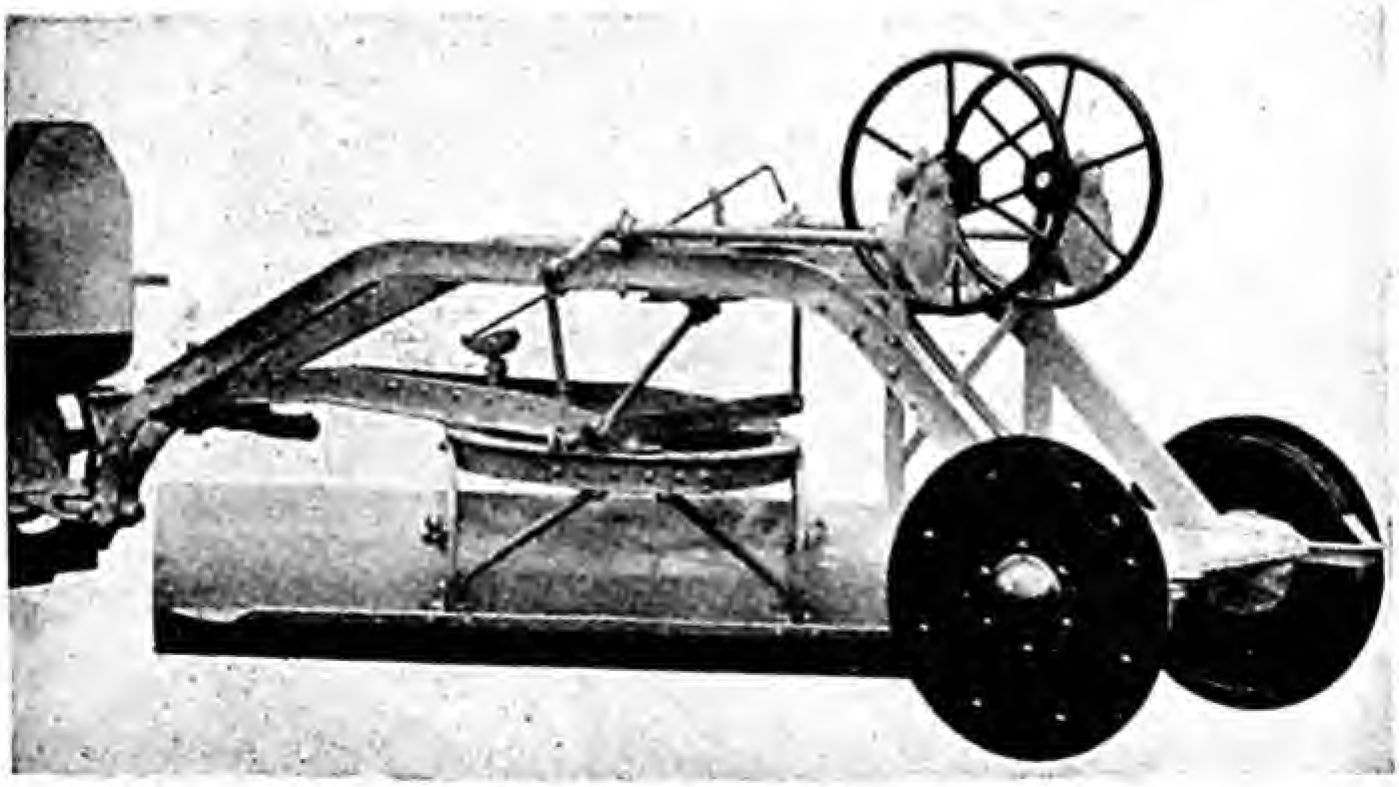


FIG. 734.—Two-wheel terracer.

makes it possible to work closer to the ends, and saves time in turning. A tongue truck can be supplied if desired (Fig. 736). The heavy channel-iron box frame is welded together, giving rigidity and strength. The frame is arched over the blade and provides ample clearance. The blade is raised and lowered by lifting cranks, operated by a hand-driven worm gear.

Two-wheel terracers are built in two sizes. The smaller weighs about 1,400 pounds and may be equipped with 8- or 9-foot blades. The larger machine weighs about 4,600 pounds and is equipped with a 10-foot blade. Simple devices are provided for changing the pitch, reversing, and horizontal shifting of the blade. With a trained tractor driver the two-wheel terracer can be handled as accurately on a terrace ridge as the four-wheel grader.

FIG. 735.—Two-wheel terracer lifted with hydraulic lift of tractor.

FIG. 736.—Tongue truck and gooseneck hitch for two-wheel terracer.

Ordinarily, from six to ten round trips are required to construct a standard broad-base terrace with a 10-foot blade. The number of rounds required depends upon the condition of the land, type of soil, size of terrace, and whether the soil is loose or hard.

585. Four-wheel Terracers or Road Graders.—Large-sized road graders (Fig. 738) and the power required to pull them are too expensive for the average farm. Unless several hundred acres are to be terraced, such an investment would not be justifiable. Most terracing with road machinery, therefore, is done with county- or government-owned equipment. A flat charge of from $2.50 to $3.50 per hour is the usual rate.

FIG. 737.—Two-wheel tractor terracer constructing a terrace.

In some sections farmers are cooperatively purchasing this type of equipment for terracing purposes. There are some sections where the charges for the use of such machinery are the actual operating expenses. On these terms costs range from $1.37 to $1.84 per hour.[1,2]

Building terraces requires stronger and more durable machines than road building requires. For efficient construction of terraces the blade

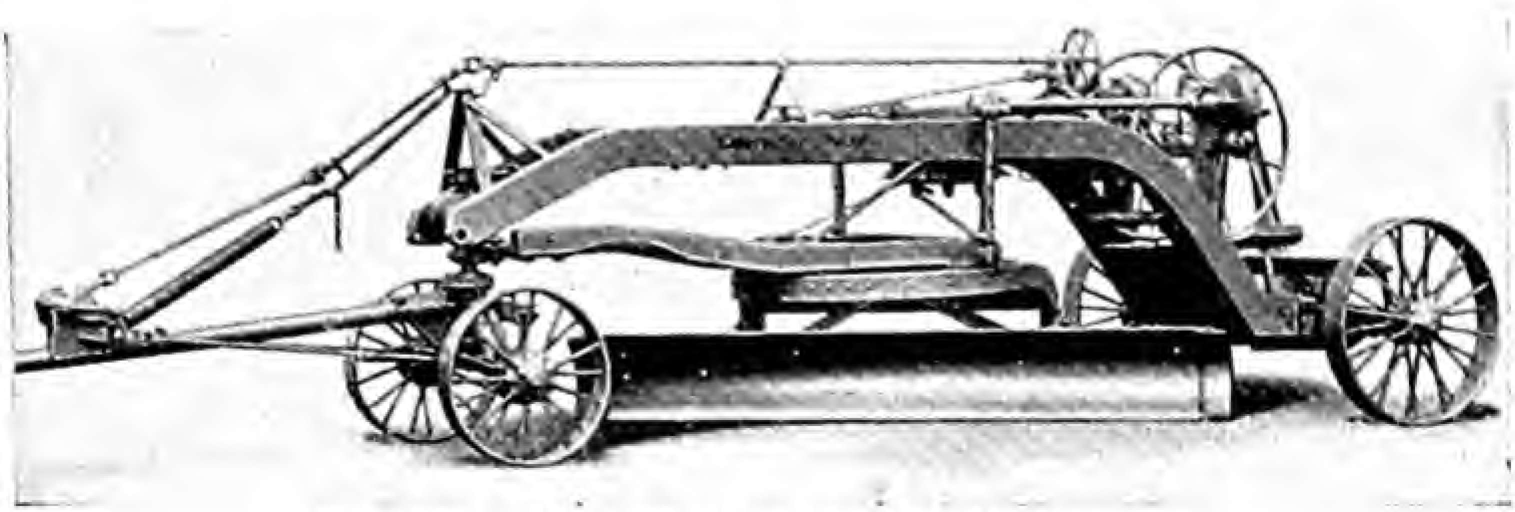


FIG. 738.—Four-wheel or road-grader terracer.

should be loaded to capacity at all times. Pulling a heavily loaded machine over rough land and around sharp curves will test the durability of any machine. Well-built road-grading terracers weigh from 10,000 to 14,000 pounds and may be equipped with 10-, 12-, or 14-foot blades. On

[1] *Agr. Eng.*, Vol. 16, No. 8, p. 315, 1935.

[2] *Proceedings of Fourth Southwest Soil and Water Conservation Conference*, 1933.

sandy-loam soils these machines are capable of throwing up a terrace 18 to 24 inches in height and 24 to 26 feet in width in three to six round trips.

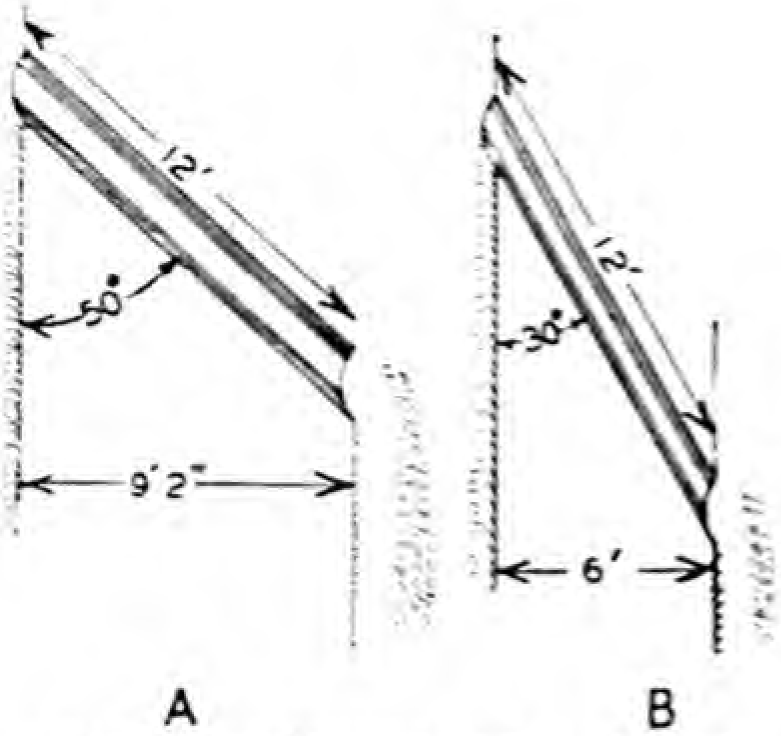


FIG. 739.—Cutting angles of grader blade: *A*, angle for moving loose soil; *B*, angle for deep cutting.

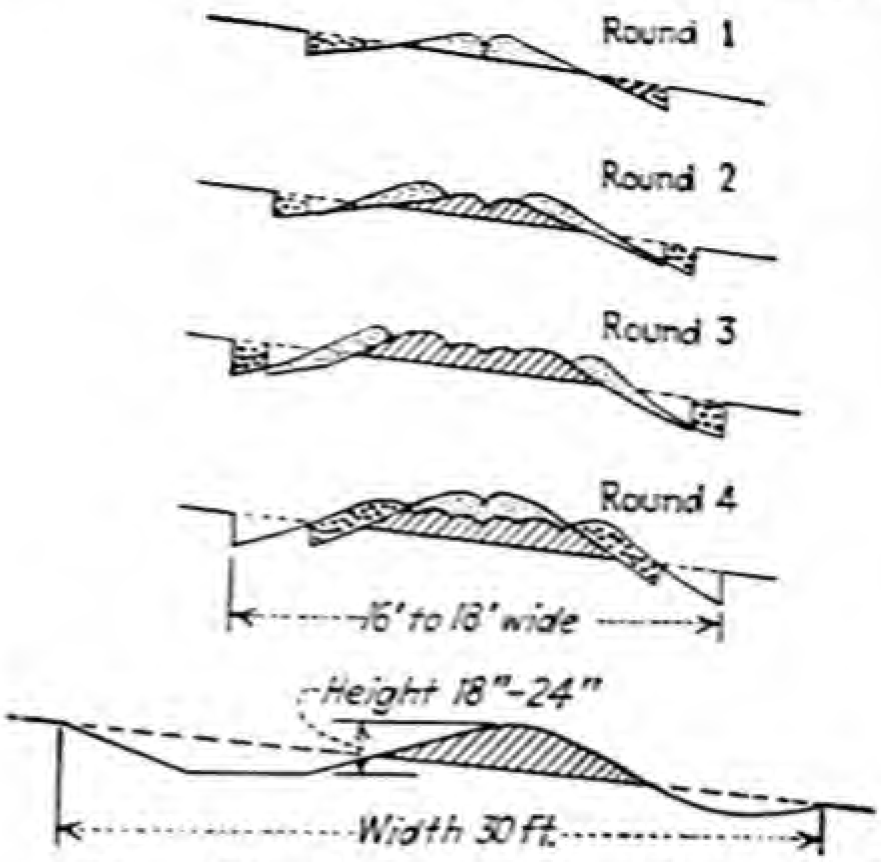


FIG. 740.—Terrace built with two-wheel terracer. The terrace is built from both sides. After fourth round terrace is finished from upper side.

586. Elevating Graders.—The elevating grader is used to a limited extent where terraces are large. This machine requires a high initial investment and is so complicated and requires so much power for oper-

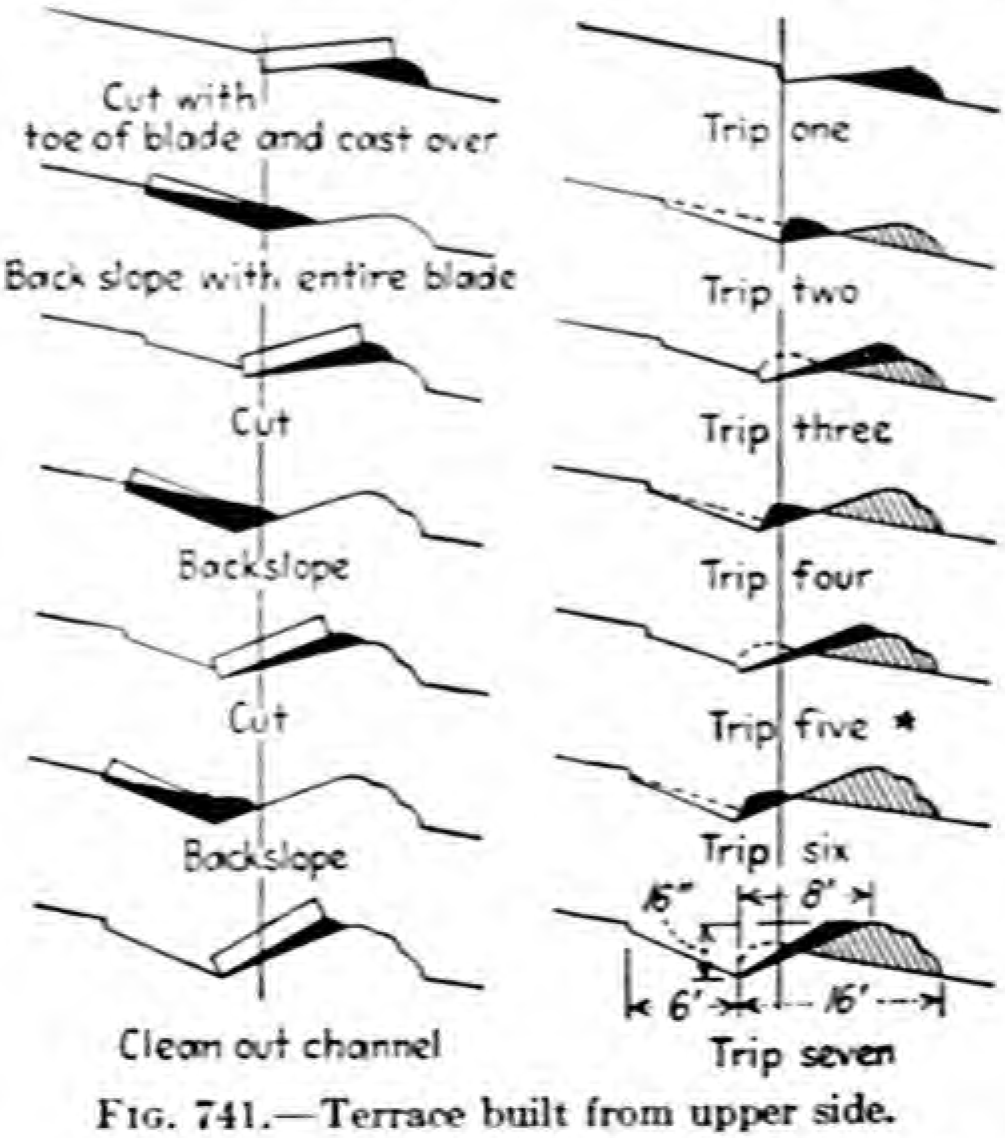


FIG. 741.—Terrace built from upper side.

ation that it is difficult to construct terraces economically with it. Generally, where a 75-horsepower tractor and elevating grader are used, a

terrace core can be built in three or four rounds (Fig. 743), after which the channel is cleaned out and the terrace smoothed up in two or three rounds with a 12-foot blade grader.

The Missouri Experiment Station has developed a small power-take-off elevating terracer that moves a good volume of earth (Fig. 744). In Missouri a 20-horsepower wheel-type tractor with the Wooley elevating terracer required 53 man-hours and 53 tractor-terracer-hours to construct a mile of terrace containing 2,825 cubic yards per mile. In Iowa with a 22-horsepower tractor the outfit required 66 man-hours and 66 tractor-terracer-hours to construct a mile of terrace containing 2,863 yards per mile.[1]

587. The Whirlwind Rotary Terracer. This terracer consists of a shortened moldboard plow to cut and lift a furrow slice up into a rapidly revolving vertical power-driven auger, which throws the soil to the

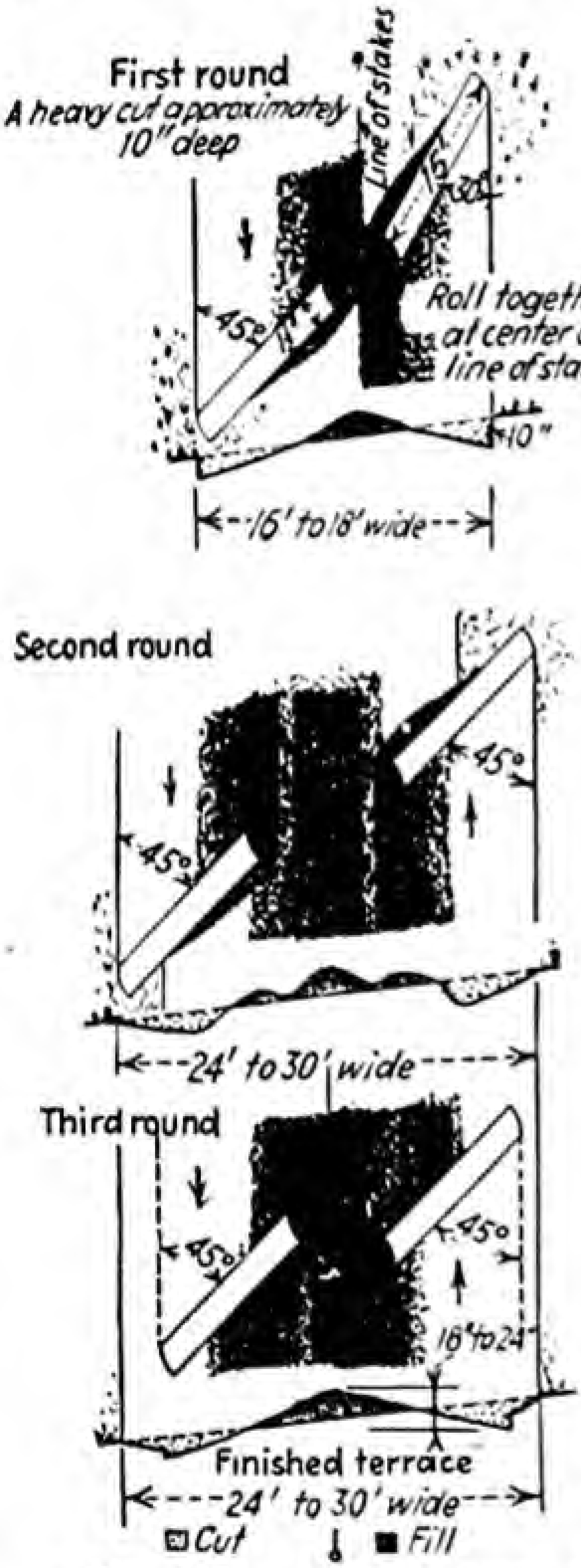


FIG. 742.—Angle of blade and cut for the first three rounds in constructing terrace with a road machine.

FIG. 743.—Large elevating grader building a terrace.

side[2] (Figs. 745 and 746). In operation the auger revolves about 1,060 r.p.m. and the tractor travels about 5 m.p.h. In Iowa with a 22-horsepower wheel-type tractor, the whirlwind terracer required 50 man-hours and 50 tractor-terracer-hours to construct a mile of terrace containing 1,899 cubic yards per mile.[1]

[1] Soil Conservation Service, U. S. Dept. Agr., unpublished data.

[2] *Agr. Eng.*, Vol. 16, No. 1, p. 6, 1935.

FIG. 744.—Light elevating grader. (*Courtesy Mo. Agr. Exp. Sta.*)

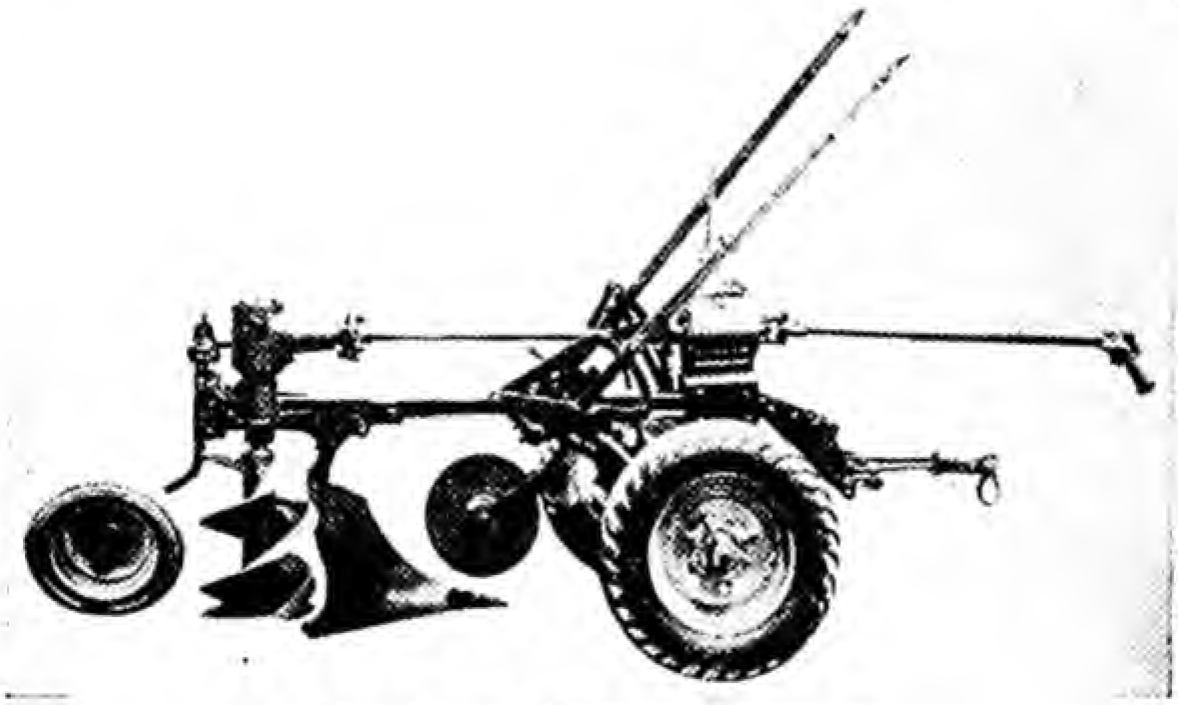


FIG. 745.—Whirlwind terracer.

FIG. 746.—The whirlwind terracer in operation.

588. Bulldozers.—The bulldozer makes an excellent tool for the filling of gullies and the building up of low sections of a terrace. Figure 747 shows a bulldozer mounted on a track-type tractor filling a gulley. Figure 748 shows a bulldozer mounted on a small tractor, and Fig. 749 shows a bulldozer blade mounted on a row-crop-type tractor.

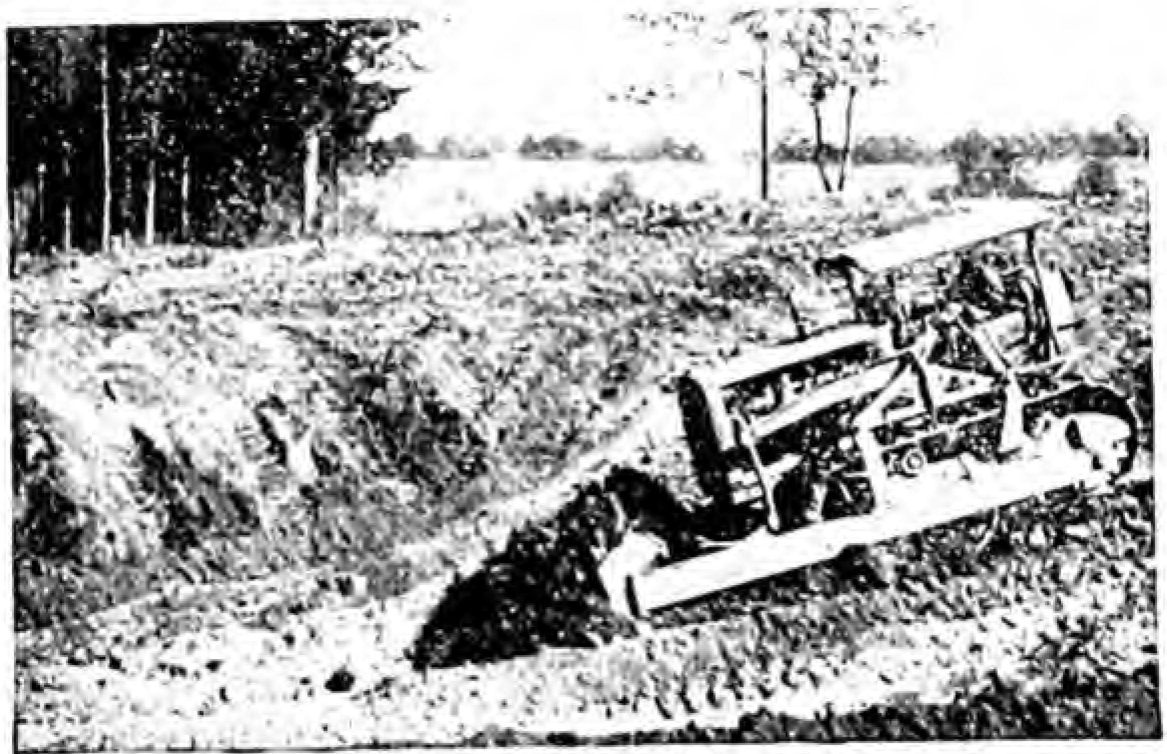


FIG. 747.—Bulldozer filling gully.

589. Cost of Constructing Terraces.—So many variables enter into terracing costs that it is hard to arrive at a definite estimate. Numerous methods of calculating costs have been tried, but the best seems to be based on the cost per foot, per 100 feet, or per mile of constructed terrace.

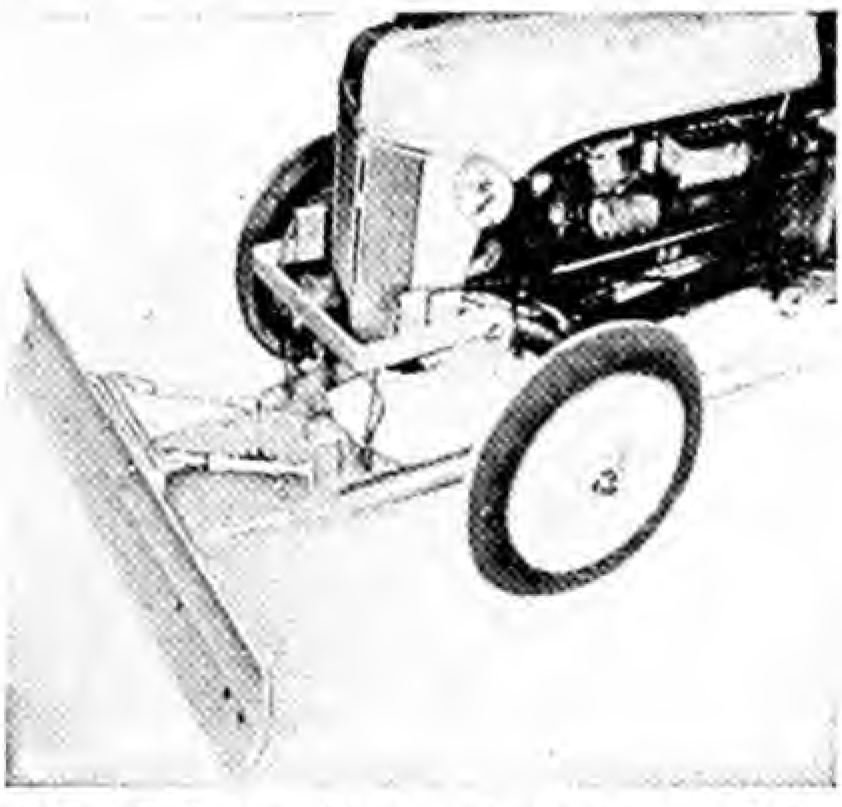


FIG. 748.—Bulldozer blade attached to small tractor.

Terraces in the Southeastern states average from 12 to 18 feet in width. In the Southwestern states terraces 20 to 24 feet wide and 18 inches high are recommended. In the High Plains of the Middle West they range from 40 to 50 feet in width. The Soil Conservation Service has adopted as a standard a width of 24 feet and a height of 18 inches with a 3-foot

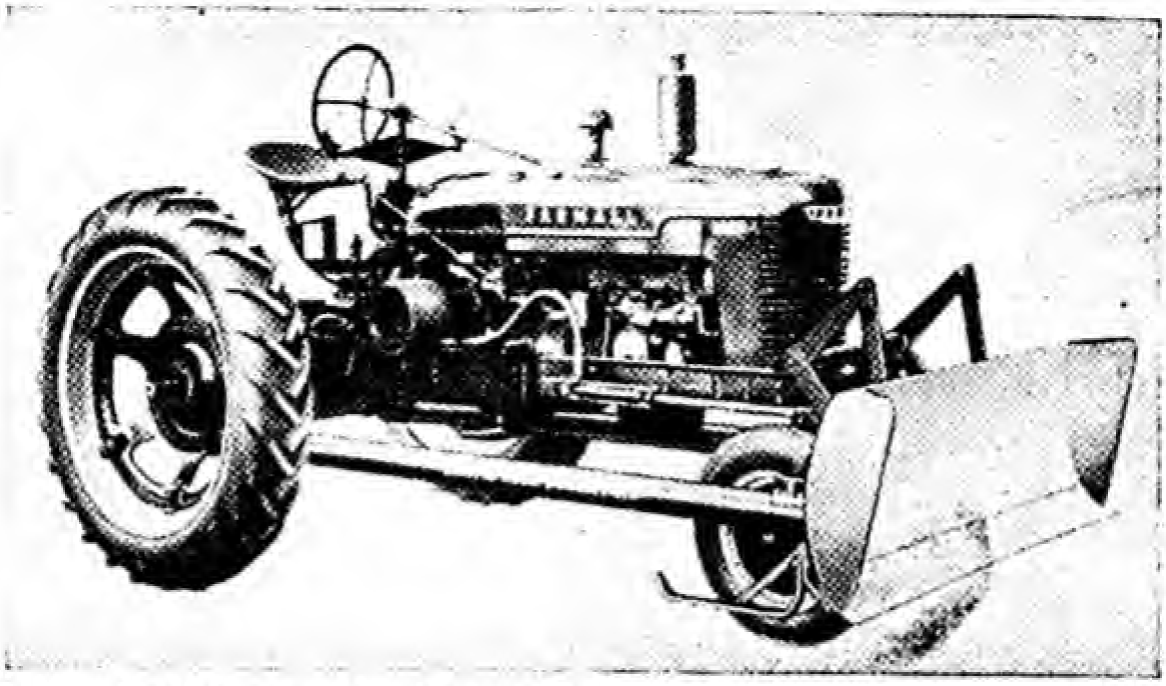


Fig. 749.—Bulldozer attachment for general-purpose row-crop tractor.

top width. Steep slopes require closer spacing of terraces than more gentle slopes. Hoover[1] enumerates the factors that must be considered in calculating the cost of terracing as follows:

1. The field or area terraced, including lineal feet of terrace necessary, the slope in per cent, soil type (surface and subsoil), vegetative cover, number of gullies to be crossed, and weather.

2. The terrace built, including cross section (height, width, and average distance dirt is moved laterally), and length.

Fig. 750.—Special sod cutter and contouring plow.

3. The equipment, including size, make, and condition, and skill of operators.

4. Cost of equipment and operating cost, including fuel consumption, grease used, depreciation, repairs and maintenance, interest on investment, and labor cost (operators).

5. Cost of engineering and supervision.

[1] *Agr. Eng.*, Vol. 17, No. 2, p. 51, 1936.

6. Cost of fresno or other work to bring low spots up to grade.
7. Outlet cost.

When all these factors are considered the cost arrived at is for the completed job and fully protected land. Unless all costs are included, it would be like a man figuring the cost of laying the foundation as the total cost of his house. Unless the low spots and gullies are filled and outlets constructed, a terrace might as well not be built at all.

Ward[1] states that eight terracing associations in Virginia built terraces at an average cost of $22.50 per mile.

Carter and Hulburt[2] state that the Rural Rehabilitation Corporation constructed terraces in Arkansas at $17.85 per mile. These costs do not include outlet construction or fills.

Baird[3] estimates the cost of building terraces in East Texas at $30.00 per mile, or more.

Data presented by Ayres[4] show the cost of constructing a terrace in Iowa was $30.97 per mile when a 15–27 tractor and grader were used and $32.65 when a general-purpose tractor and three-wheel farm grader were used. He also gives data on the cost of constructing terraces with several other types of machines.

Table XXI gives the various items of cost for building 124 miles of terrace in the vicinity of San Angelo, Texas.

TABLE XXI.—COST OF CONSTRUCTING 124 MILES OF TERRACE IN THE VICINITY OF SAN ANGELO, TEXAS

Miles of terrace built	Labor	Transportation	Fuel	Depreciation	Total cost	Cost per mile	Total number of hours running	Number of hours per mile
124	$1,511.26	$211.12	$528.78	$1,254.21	$3,505.67	$28.27	2110	17.01

NOTE.—Labor charge $0.335 per hour.
Depreciation on tractor $0.471 per hour.
Depreciation on grader $0.121 per hour.
Transportation of crew to and from work charged at the rate of $0.02 per hour.

[1] *Extension Service Rev.*, Vol. 7, No. 7, p. 105, 1936.
[2] *Agr. Eng.*, Vol. 17, No. 12, p. 511, 1936.
[3] *Agr. Eng.*, Vol. 16, No. 1, p. 5, 1935.
[4] *Soil Erosion and Its Control*, McGraw-Hill Book Company, Inc., p. 168, 1936.

PART XV

LABORSAVING EQUIPMENT

CHAPTER XXXIV

ELEVATORS, POWER LOADERS, AND POST-HOLE DIGGERS

The handling of farm products such as wheat, oats, milo, shelled and ear corn, bales of hay, and manure is backbreaking manual labor. Power-operated equipment is now available whereby manual labor is often reduced to the operation of a power unit such as a tractor. Two types of laborsaving equipment are *elevators* and *power loaders.*

ELEVATORS

In general the elevators used on the farm may be classified as *portable elevators* and *stationary elevators.*

590. Portable Elevators.—The portable elevator makes the farmer's life easier and farm work faster and helps to solve labor shortages. The

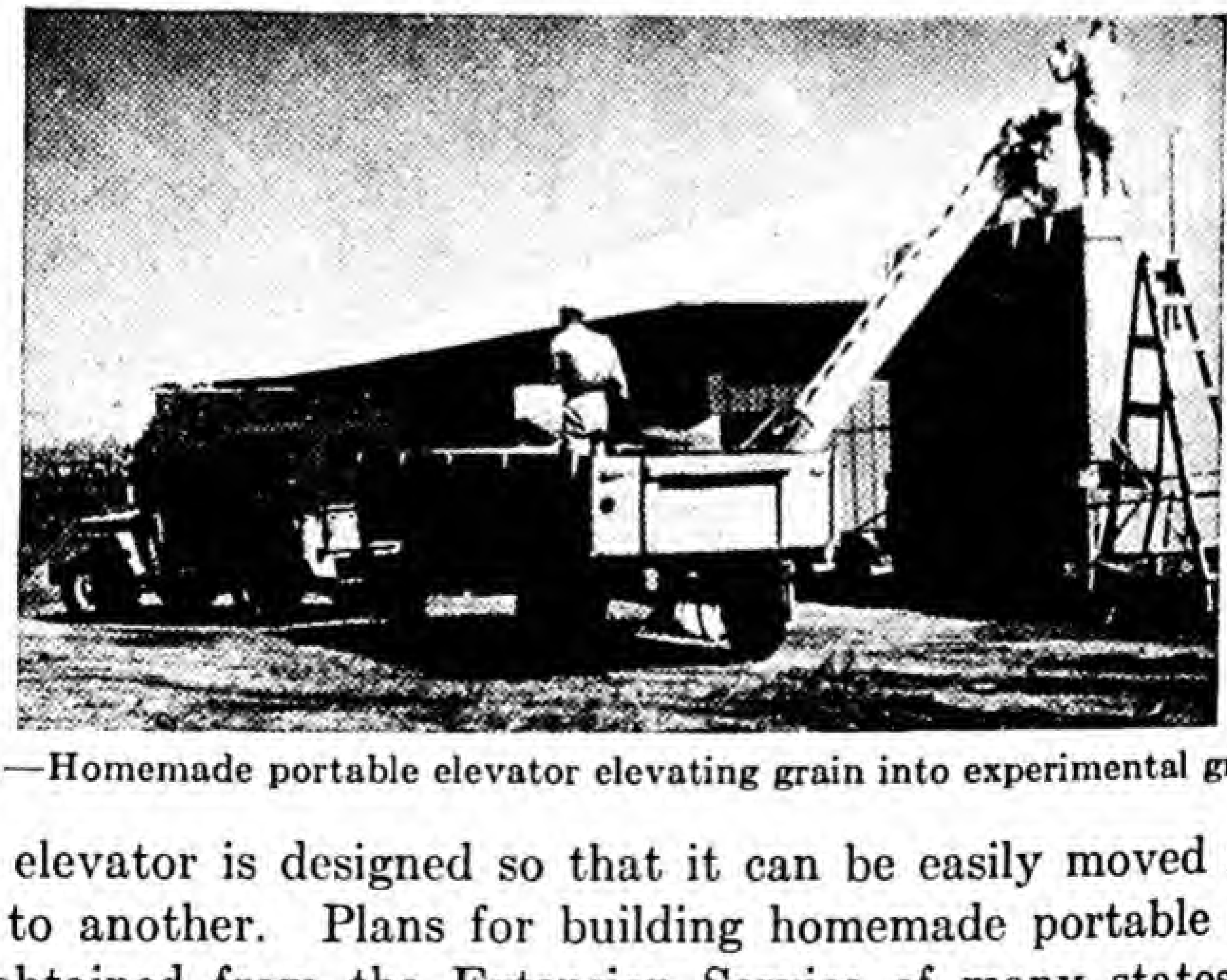


FIG. 751.—Homemade portable elevator elevating grain into experimental grain drier.

portable elevator is designed so that it can be easily moved from one location to another. Plans for building homemade portable elevators can be obtained from the Extension Service of many states. Many different sizes and types are being manufactured. Figure 751 shows a homemade portable elevator which will handle any of the small grains. Tests with the elevator set at 20 degrees show that it can elevate 40,000

pounds of milo and 35,000 pounds of shelled corn per hour. At 40 degrees, 30,000 pounds of milo and 20,000 pounds of shelled corn can be elevated per hour.

FIG. 752.—Portable elevator elevating ear corn. An electric motor or small gasoline engine can be belted to the elevator for power. The flights can be reversed and small grain elevated through bottom section.

Many farmers have made portable elevators for the handling of chopped feed, ear corn, and baled hay.

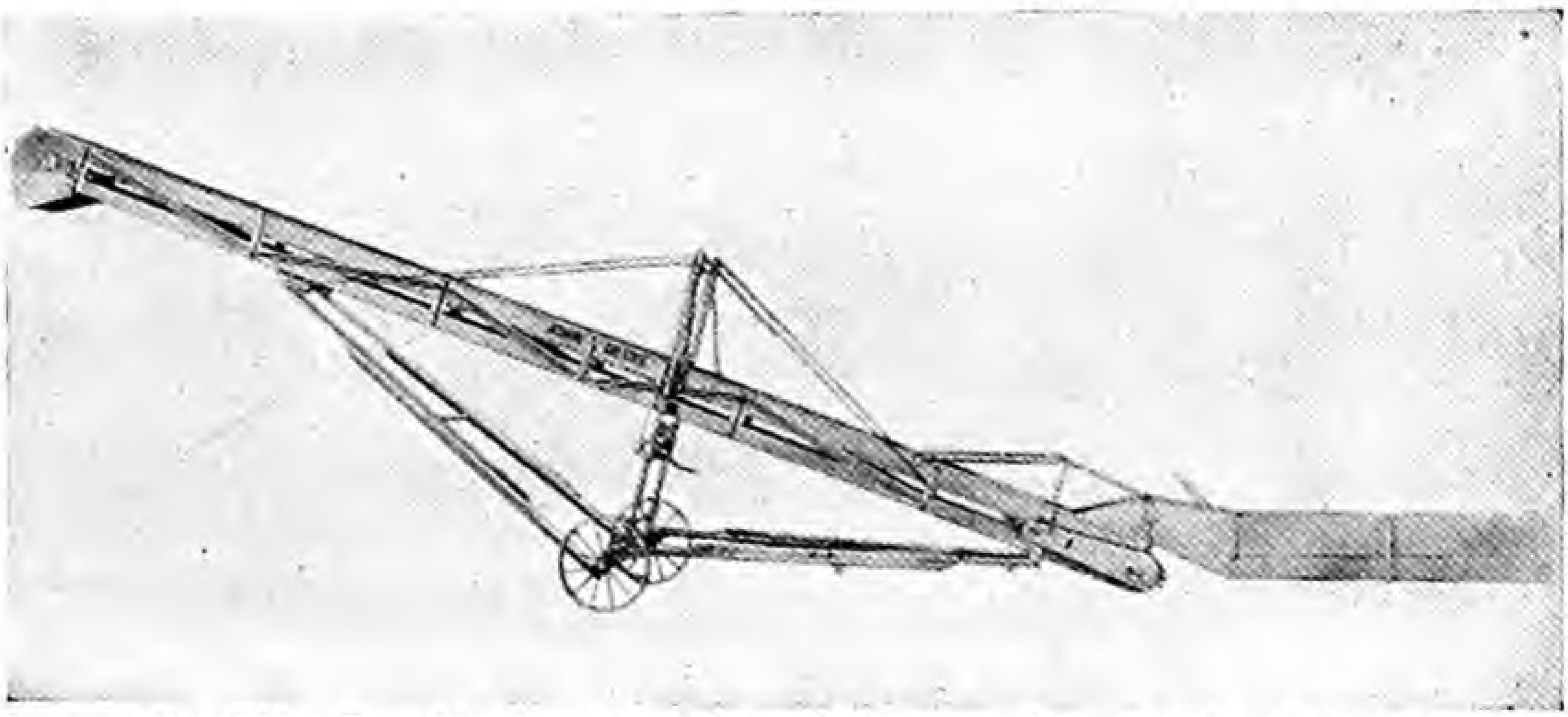


FIG. 753.—Portable elevator with truck hopper and power-take-off drive.

Figure 752 shows a commercial portable elevator equipped with a reversible chain flight which can be used to elevate either small grain or ear corn. Small grain is elevated when the flight is pulled through the enclosed bottom section of the box, and ear corn or bales of hay can be

elevated by reversing the direction of travel of the flight so that it is upward over the open top section.

Where long heavy portable elevators are used, a special derrick lifting arrangement (Fig. 753) enables one man to raise the long chute to any height desired. The average angle for satisfactory operation

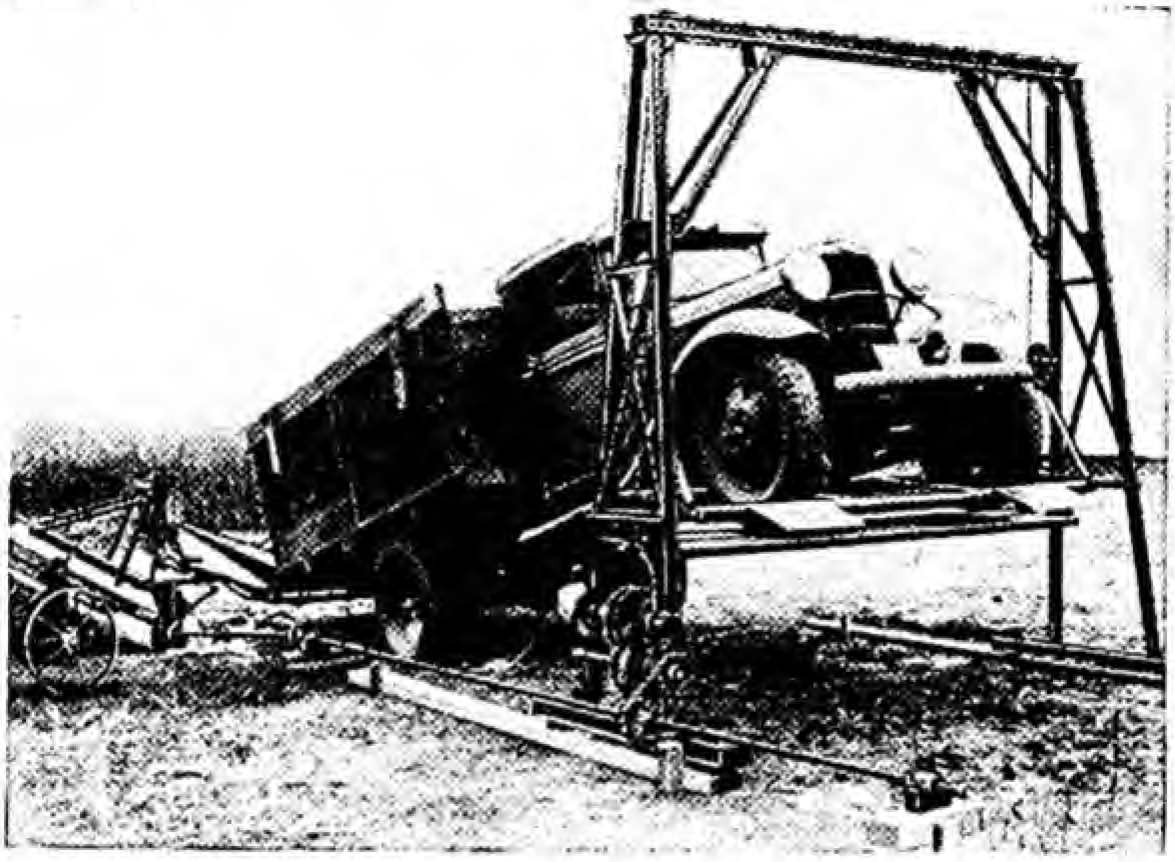


FIG. 754.—Jack for raising wagon or truck to dump grain into elevator hopper.

varies from approximately 20 to 45 degrees. Greater angles can be used, but they reduce the capacity of the elevator. Hoppers are provided so that grain can be dumped into the elevator directly from the truck (Fig. 754). The hopper can be folded for transportation (Fig. 755). Special derricks for lifting the front end of a wagon, trailer, or truck

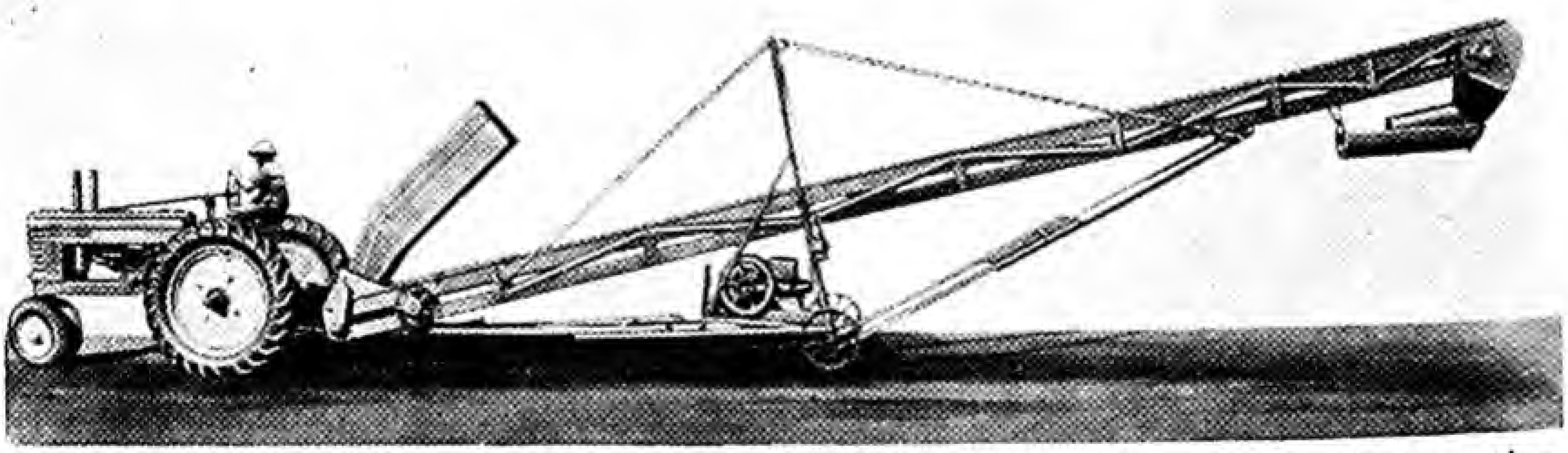


FIG. 755.—Portable elevator with hopper folded, belt attachment, gasoline engine mounting, and swivel spout, ready for transport on the road.

permit the grain to flow out of the vehicle by gravity (Fig. 754). When bales of hay are elevated, wide elevator chutes let the bales rest directly on the chain flights (Fig. 756). If the elevator chute is narrow and has flaring sides, bales of hay can be placed at an angle so that one corner of the bale rests upon the flights.

Auger-type portable elevators consist of a long enclosed section of a

FIG. 756.—Portable elevator being used to elevate bales of hay into the barn.

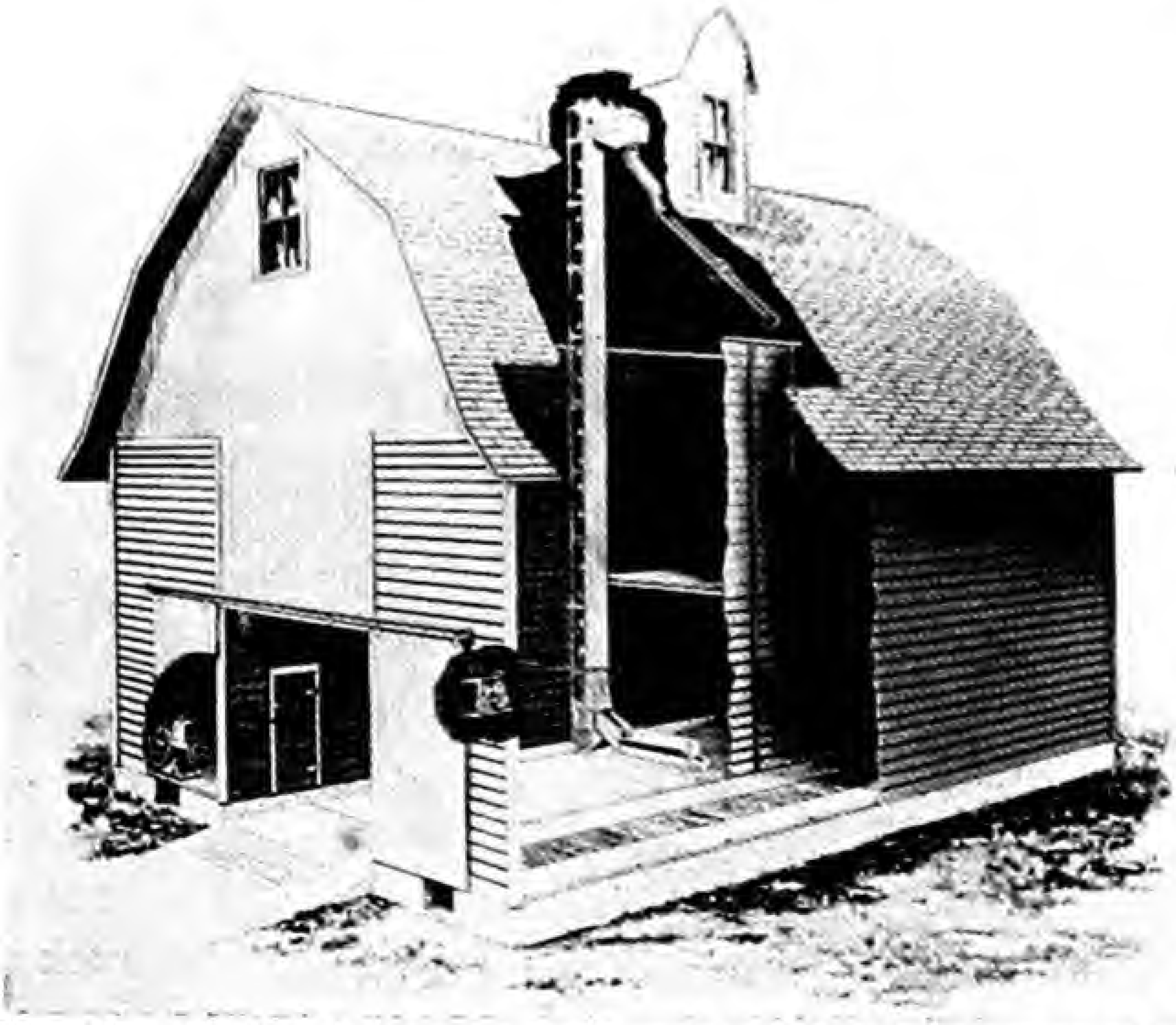


FIG. 757.—Bucket elevator for small grain installed in driveway of barn.

screw conveyor. The lower end of the screw is not enclosed; when inserted in a pile of grain, the revolving auger automatically picks up the grain and conveys it to the other end.

591. Field Baled-hay Pickup Elevators.—This type of elevator is described in the chapter on Hay-harvesting Machinery.

592. Barn Elevators.—Where a farmer has a barn with bins for the storage of small grain and corn, he may wish to install a permanent elevator such as those shown in Figs. 757 and 758. Several types can be obtained, but these are typical. The elevator chute is set vertical or

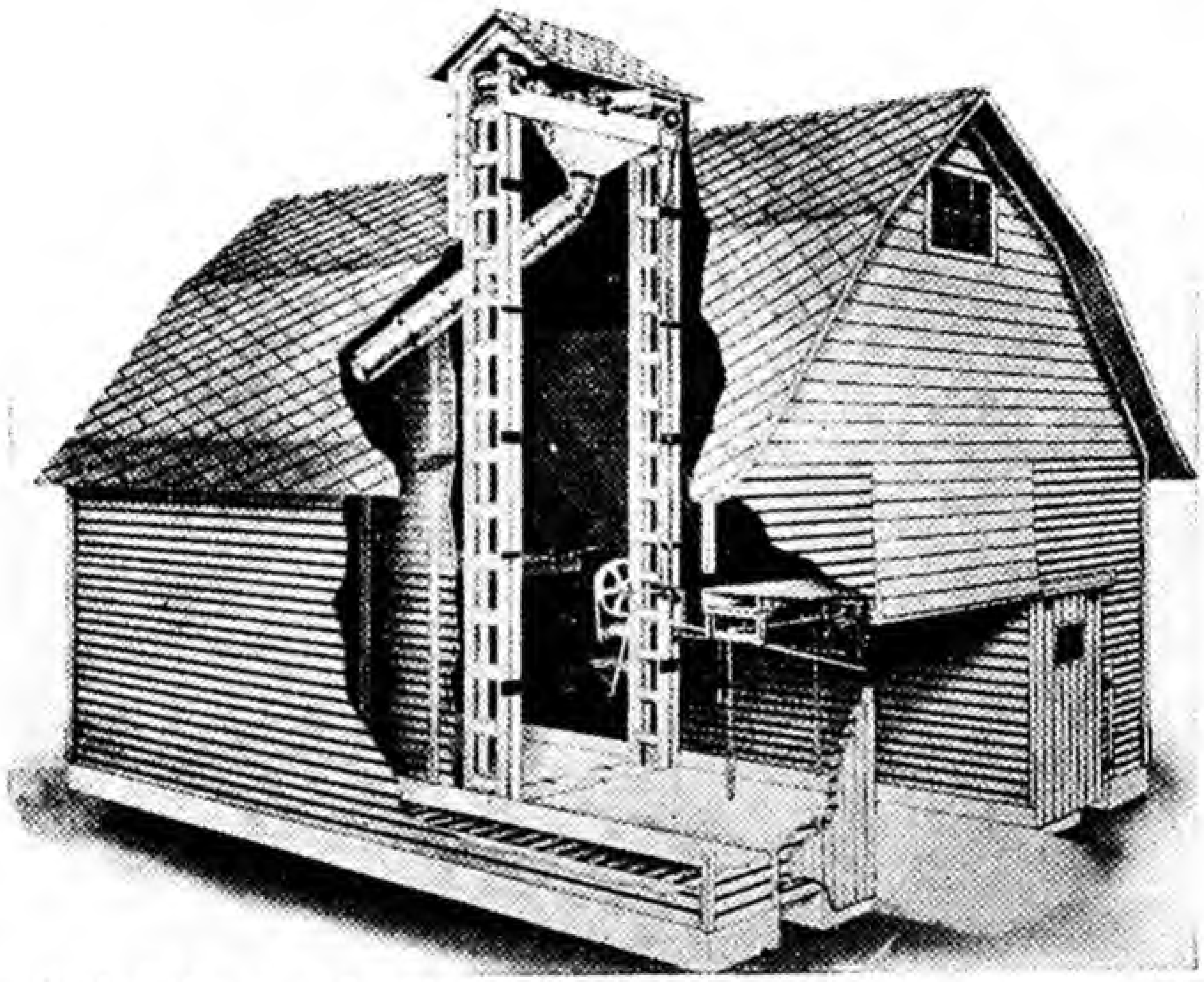


FIG. 758.—Bucket elevators for the barn. Elevator across the driveway. The grain is unloaded into a pit underneath the driveway.

almost vertical, so that cups attached to chains can be used to elevate the grain.

593. Grain Blower Elevators.—The blower-type elevator is useful where large quantities of grain are handled. Blowers have been designed so that the grain passes through the fan housing on a cushion of air without being hit and cracked by the fan blades. Figure 759 shows a blower elevator for grain. The grain is dumped from the truck into the blower hopper, from which it is fed into the stream of air. Small blowers are attached to the truck body and driven by a special power-take-off. Grain blowers will elevate from 300 to 1,200 bushels of grain per hour to heights of 25 to 30 feet. A 5-horsepower electric motor has sufficient power to operate the average-sized blower.

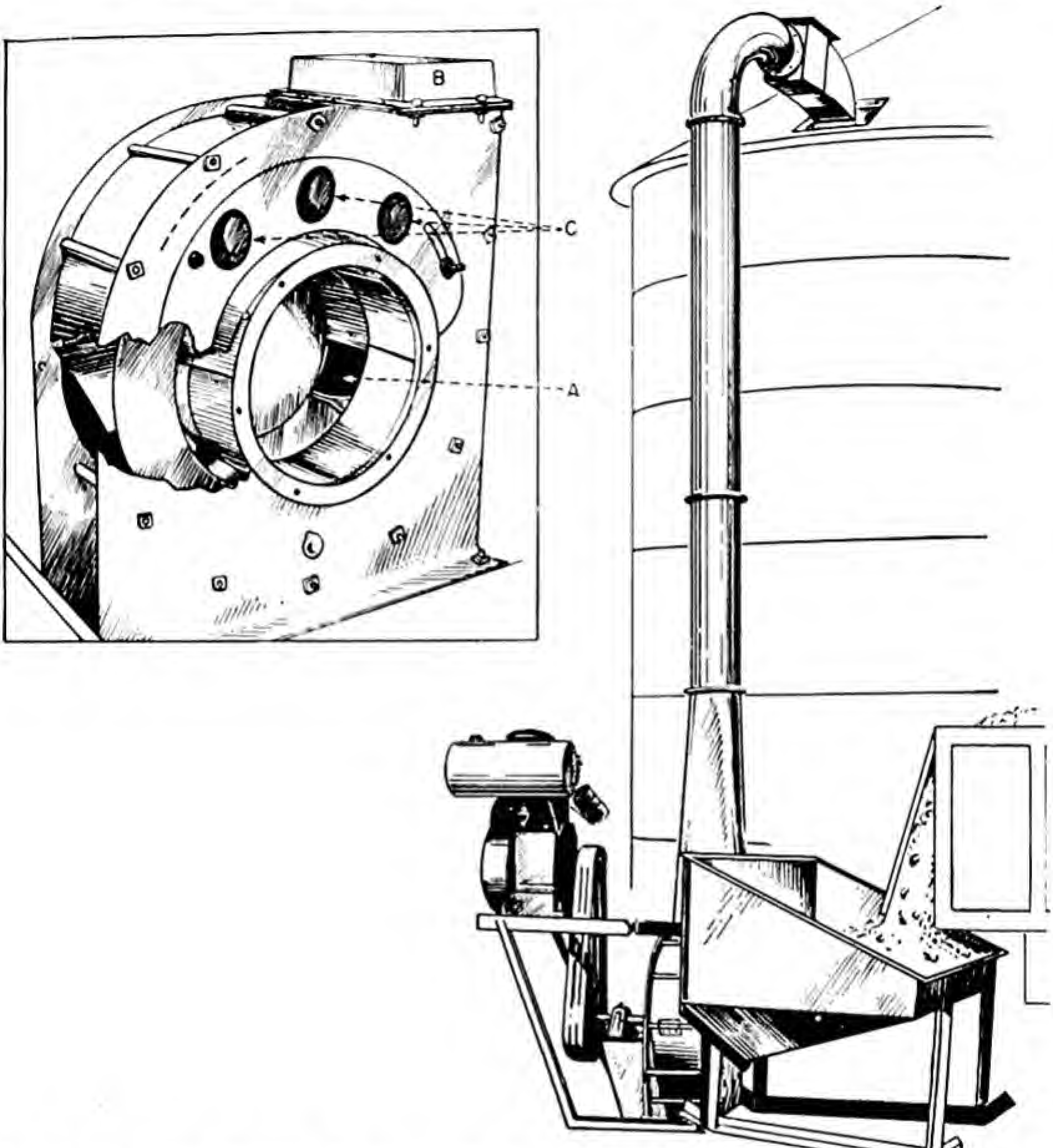


FIG. 759.—Blower elevator showing method of unloading grain into hopper and pipe to grain tank on right. *Left*, the fan housing is shown with auxiliary air ports.

FIG. 760.—Grain blower elevator attached to truck.

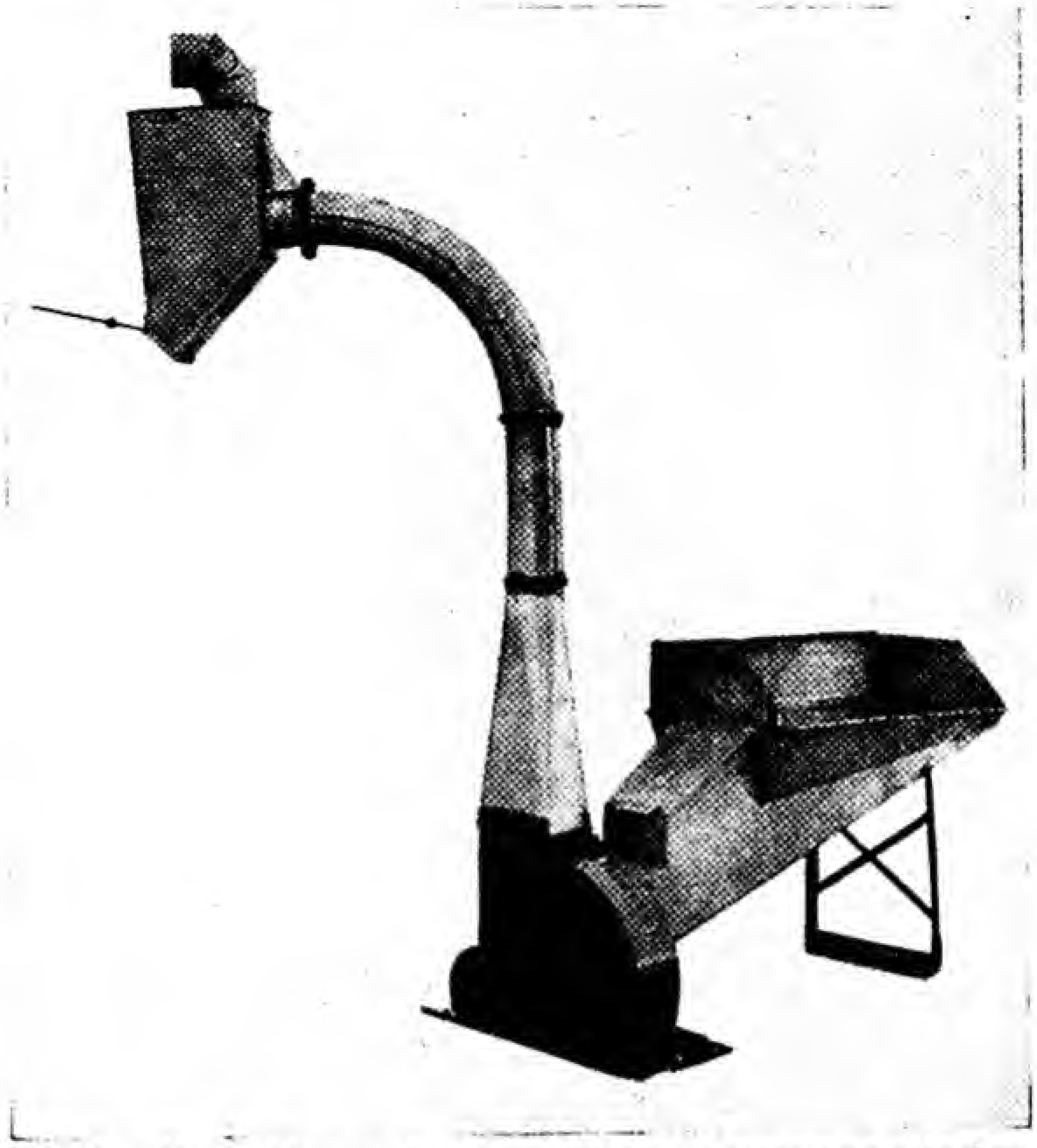


FIG. 761.—Grain blower elevator with smut-removing attachment.

594. Silage Blowers.—This type of blower elevator was described under Silage Cutters and Harvesters.

POWER LOADERS

The tractor-mounted power loaders shown in Figs. 762 and 763 are also called *manure loaders.* They received this name, no doubt, because this type of machine was developed largely for the loading of manure. It has, however, many other uses. It can be used to load onto trucks bales of cotton, baled hay, dirt, gravel, sand, and many other materials.

FIG. 762.—Power loader loading manure into manure spreader.

If manure is to be loaded in a barn where the ceiling is low, a loader should be selected with the lifting beams arranged so they do not rise up and hit the ceiling before the scoop has been lifted high enough to

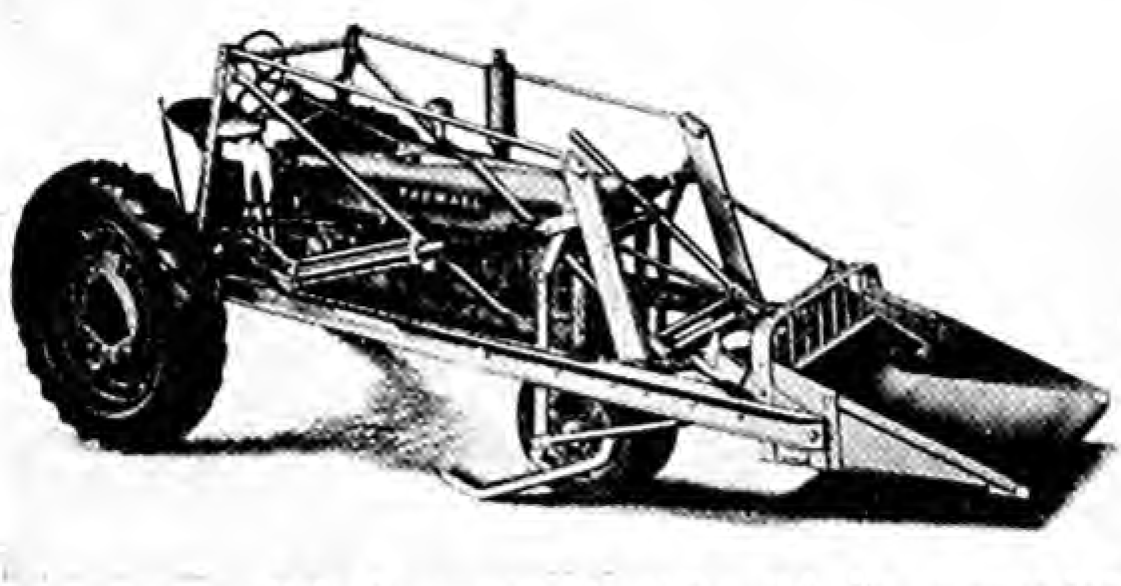


FIG. 763.—Front-mounted loader equipped with solid slip-scraper-type scoop. Note the jack for breaking the load loose before the weight of the load is placed on the tractor tires.

dump into the manure spreader. The loader shown has a frame linkage that permits the load being lifted above the highest part of the machine.

Most power loaders use hydraulic power for lifting the scoop, but a few use mechanical winches or a block and tackle. The loader shown in

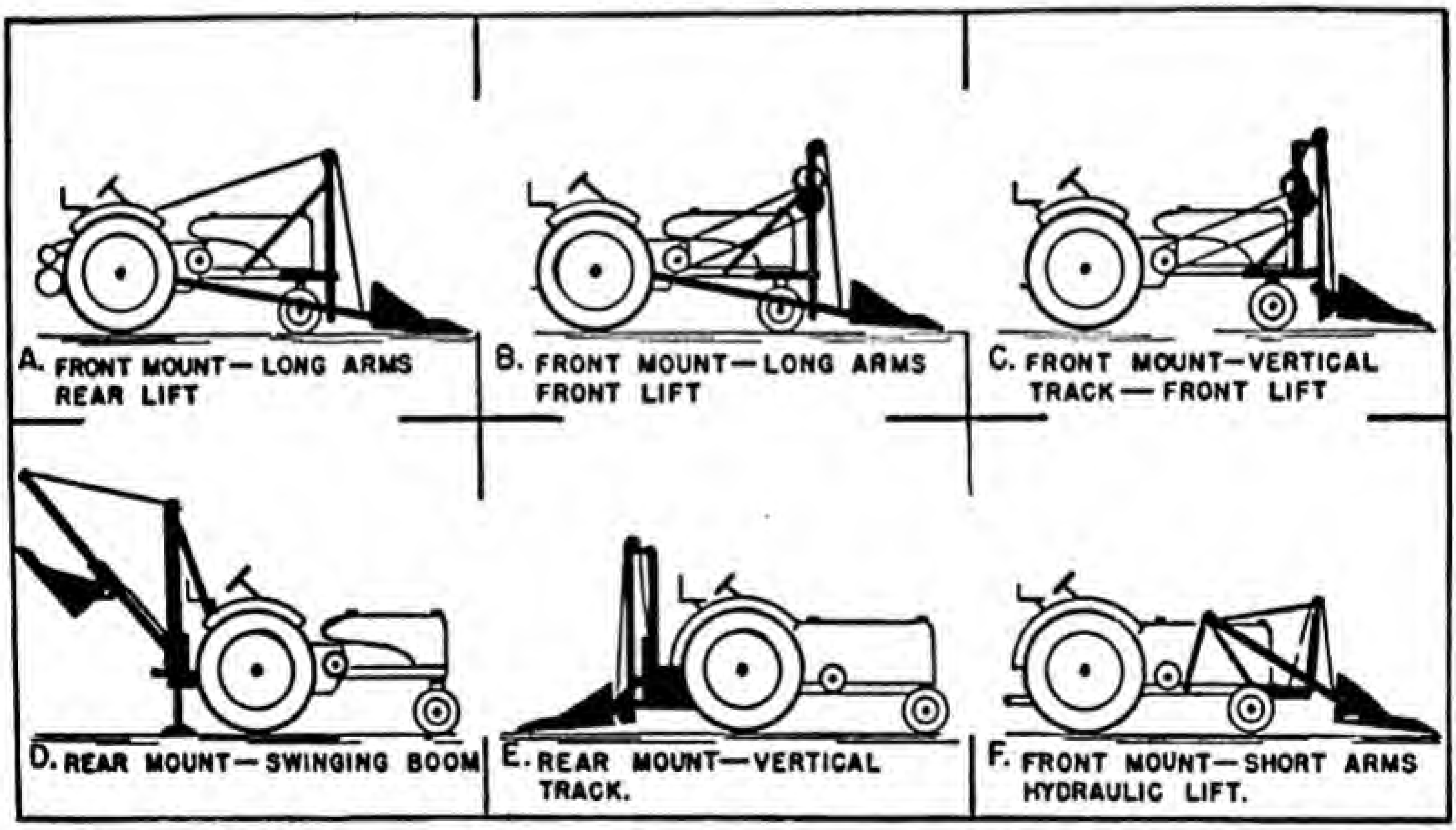


FIG. 764.—Methods of mounting power loaders on tractors. (*South Dakota Agr. Expt. Sta., Bull.* 378, 1944.)

Fig. 763 is equipped with a special jack to break the load loose before the weight is thrown on the tractor tires.

There are a number of methods of mounting power loaders on tractors, as shown in Fig. 764. The front-mounted arrangement appears to be the

FIG. 765.—Front-mounted derrick-type hoisting mechanism.

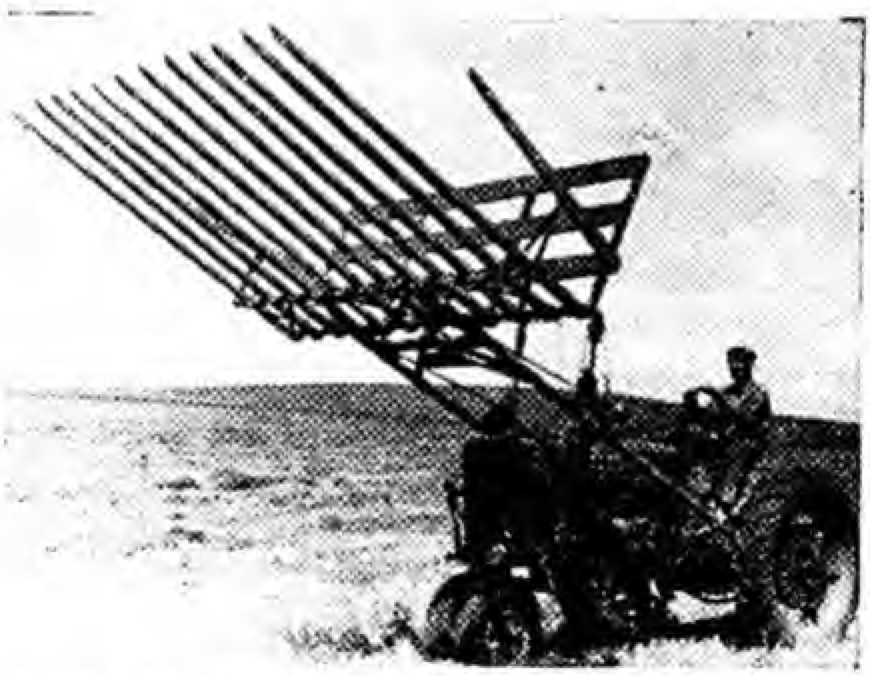


FIG. 766.—Front-mounted loader with sweep rake attached in place of manure fork.

FIG. 767.—Front-mounted loader equipped with dozer blade in place of the manure fork.

FIG. 768.—Mechanical lift mounted on rear of tractor equipped with winch and block and cable.

most popular. Figure 765 shows a tractor-mounted derrick-type sweep rake and hay stacker equipped with a mechanical lift. Figure 766 shows a front-mounted power loader with a hydraulic lift. The same loader is shown in Fig. 767 equipped with a dozer blade. Figure 768 shows a mechanical lift which uses a winch and block and cable.

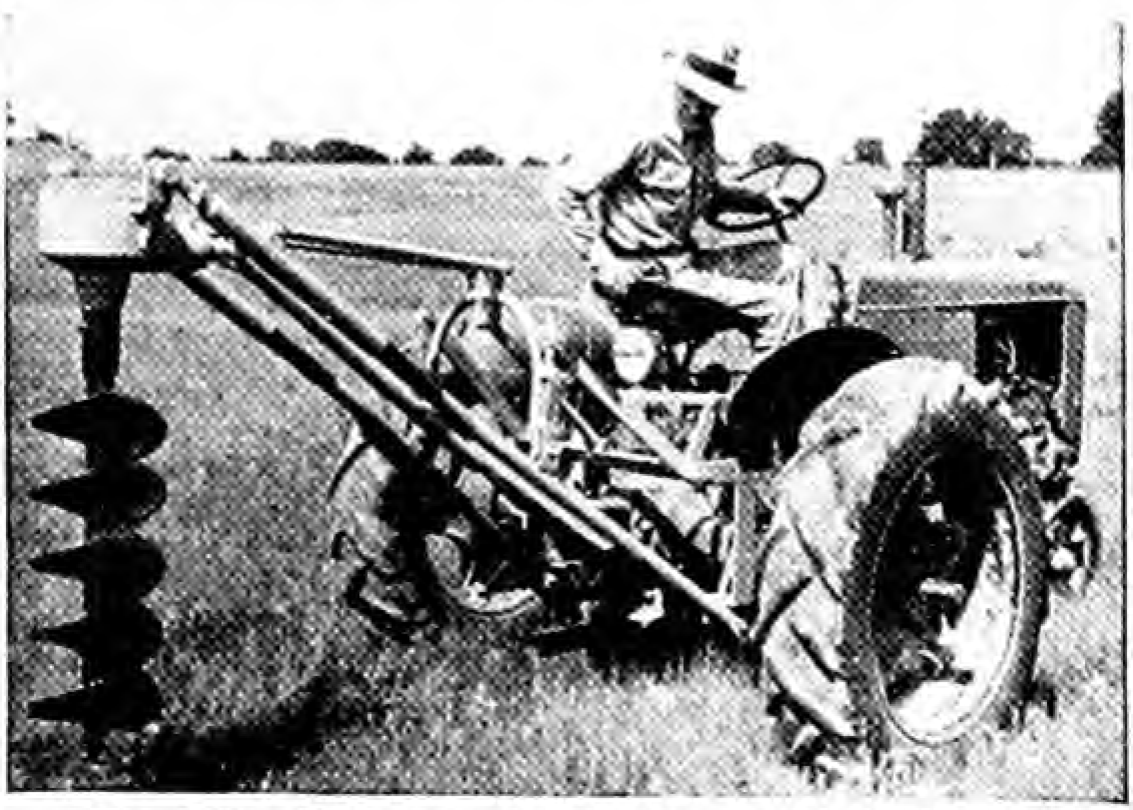


FIG. 769.—Rear-mounted tractor post-hole digger.

FIG. 770.—Front-mounted tractor post-hole digger.

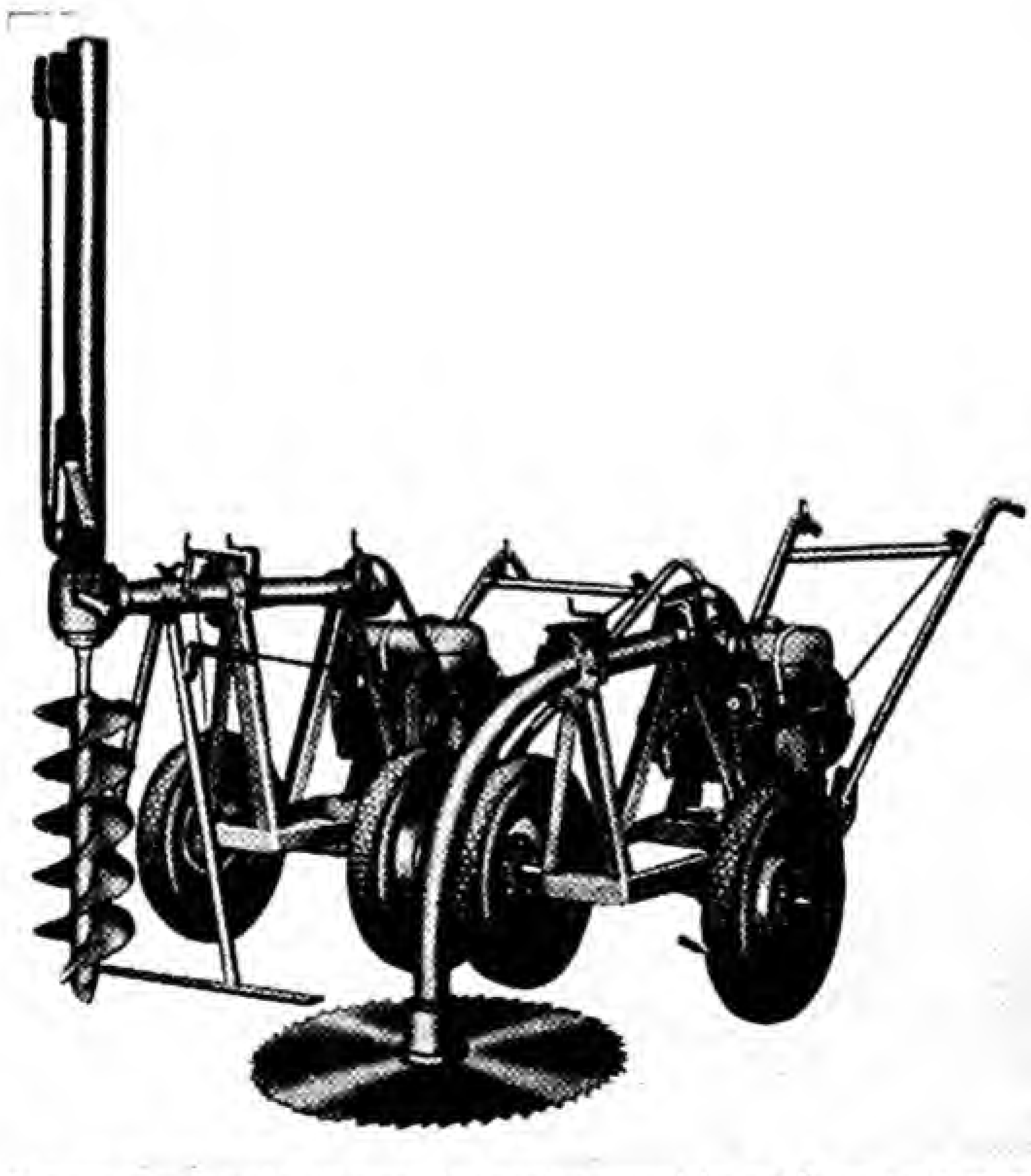


FIG. 771.—Power post-hole digger interchangeable with power-saw attachment.

POWER POST-HOLE DIGGERS

The digging of post holes to build fences about the farm and pasture is slow hard work when done by hand. Power-driven post-hole diggers make the job easier and many times faster. A power-driven post-hole digger with power pressure and lift can dig a standard post hole in a few seconds. Most power post-hole diggers are tractor-mounted (Figs. 769 and 770). Figure 771 shows, however, a post-hole digging attachment for a portable power saw. The two units are interchangeable. The majority of post-hole-digging attachments are mounted on the rear of the tractor so the power can be obtained from the power-take-off (Fig. 769). The best power post-hole diggers have an arrangement so that pressure can be applied to force the auger into the soil and a power-lifting device to lift the auger from the hole.

PART XVI
PASTURE MACHINERY

CHAPTER XXXV

BRUSH REMOVAL AND THE APPLICATION OF FERTILIZER AND LIME

Much attention is being given to pasture improvement by the removal of noxious brush and weeds and the application of fertilizers, especially phosphates and lime. This, naturally, calls for special machines for both the removal of noxious plants and the application of plant food and soil neutralizers.

Machinery used for the removal of brush are mowers, power saws, weed and brush stalk cutters, and other special equipment. Fertilizer and lime may be broadcast over the pasture, but it is believed that better results are obtained if the fertilizer is placed in the soil.

REMOVAL OF BRUSH

595. Mowers.—Weeds and small sprouts can be controlled to a large extent by the timely use of the ordinary hay mower. The tractor-

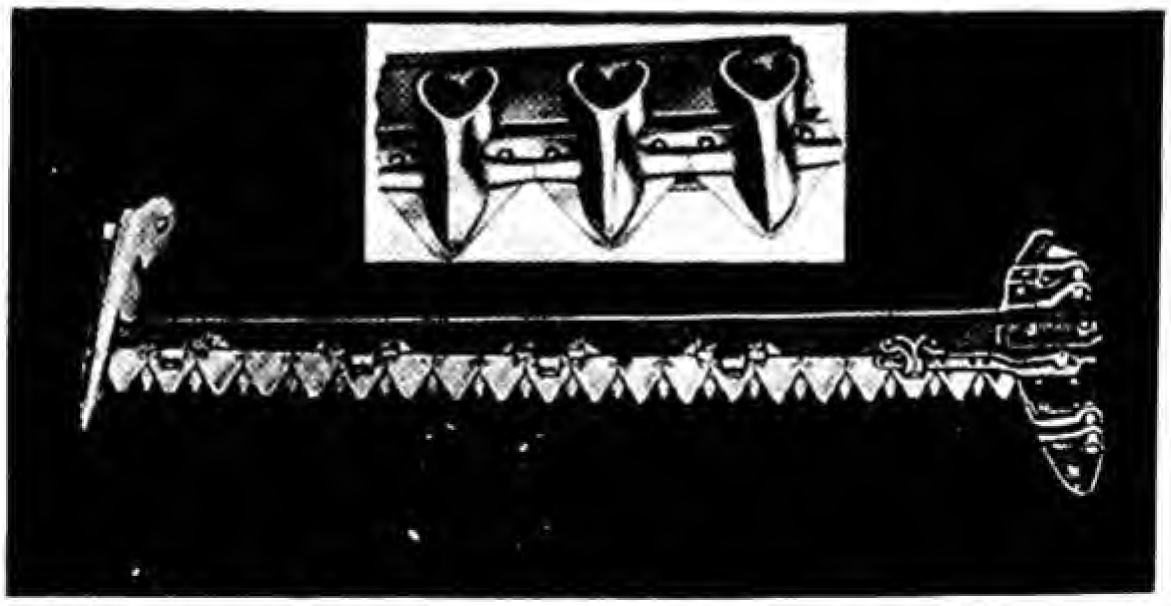


FIG. 772.—Cutter bar of mower equipped with round-nosed stub guards and extra-heavy knife sections. The inset shows a section of the underside of brush or weed cutter bar.

operated mower appears to be the most popular with farmers. The mower is used without any changes. If there are many sprouts and fairly large brush, up to $1\frac{1}{2}$ inches in diameter, a special brush cutter bar should be used (Fig. 772). The mower is operated by the power-

take-off of a tractor. The cutter bar is equipped with round-nosed stub guards that do not have lips above the knife sections (Fig. 772). The knife has extra-heavy sections. In cutting brush, the tractor should be

FIG. 773.—Power saw mounted on row-crop-type tractor. Note that the saw is driven by belt on the tractor pulley and that the saw is to the front and left of the tractor.

operated in low gear. This allows the knife to run fast in comparison to the forward rate of travel.

596. Power Saws.—Two types of power saw have been developed in recent years. One type is an attachment for farm tractors. It is

FIG. 774.—Position of saw for cutting brush and undergrowth with tractor in motion. Brush may be cut off even with the ground or any height desirable to run mower.

generally mounted on the general-purpose row-crop-type tractor (Fig. 773), but some saws are designed for the four-wheel-type tractor (Fig. 774). Another type of power saw consists of a complete unit with a small engine and circular saw mounted on two wheels. Some are self-propelled (Fig.

775), while others must be moved manually (Fig. 776). Most power saws are equipped with circular saws. The tractor power saw may be

FIG. 775.—Self-propelled power saw in position to fell a tree. By revolving the power shaft and housing, the saw can be used to cut timber into log or pulpwood lengths.

equipped with a saw 5 feet in diameter, while the two-wheel cart-type saw is equipped with saws ranging from 2 to 3 feet in diameter. Either type of power saw can be used to cut brush, fell trees, and mow weeds

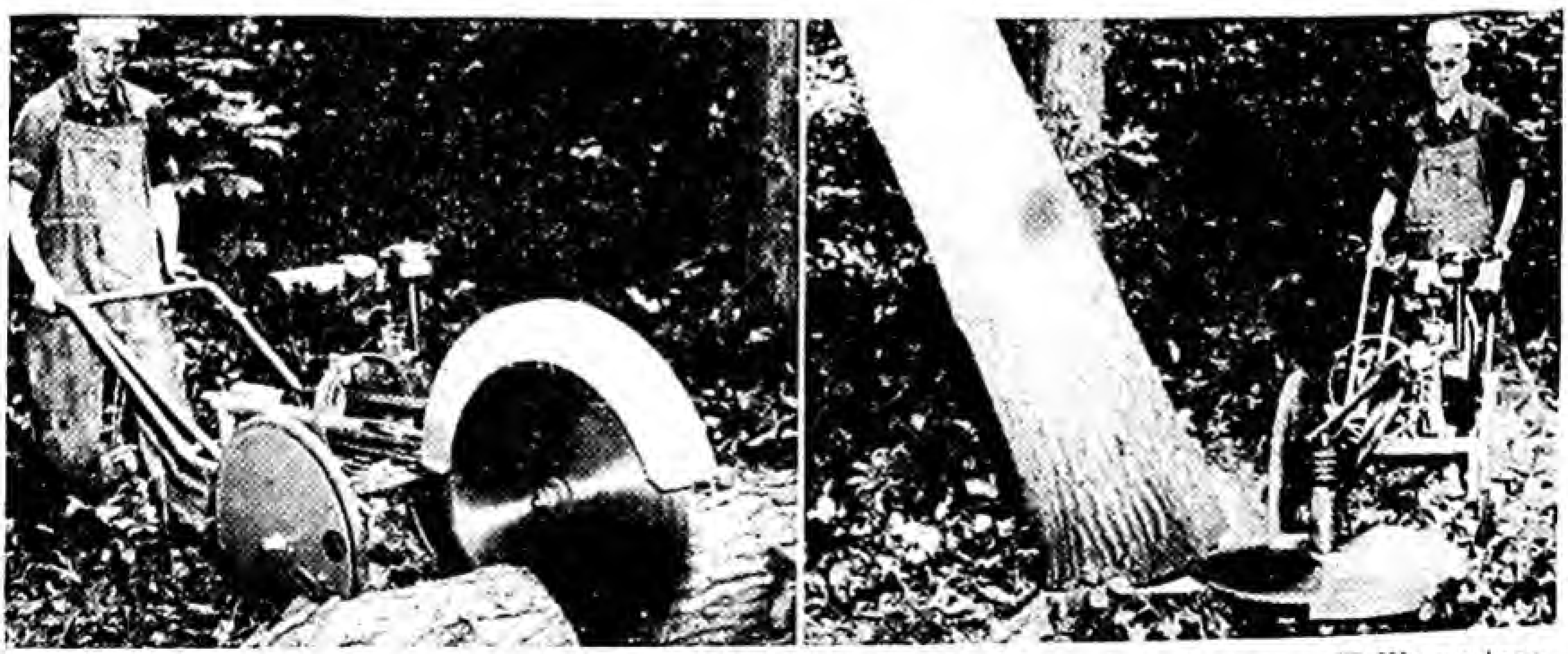


FIG. 776.—Power saw mounted on two wheels and pushed from tree to tree. Felling a tree, *right*, and sawing log lengths, *left*.

and sprouts. It can also be used to saw off stumps within an inch or two of the ground. Most of the power saws can be used either to fell

standing trees or to cut them into sections as the tree lies on the ground. Figure 777 shows a two-wheel power chain saw.

597. Brush Stalk Cutters.—Figure 778 shows a stalk cutter equipped with twelve blades. The standard stalk cutter has only five to seven

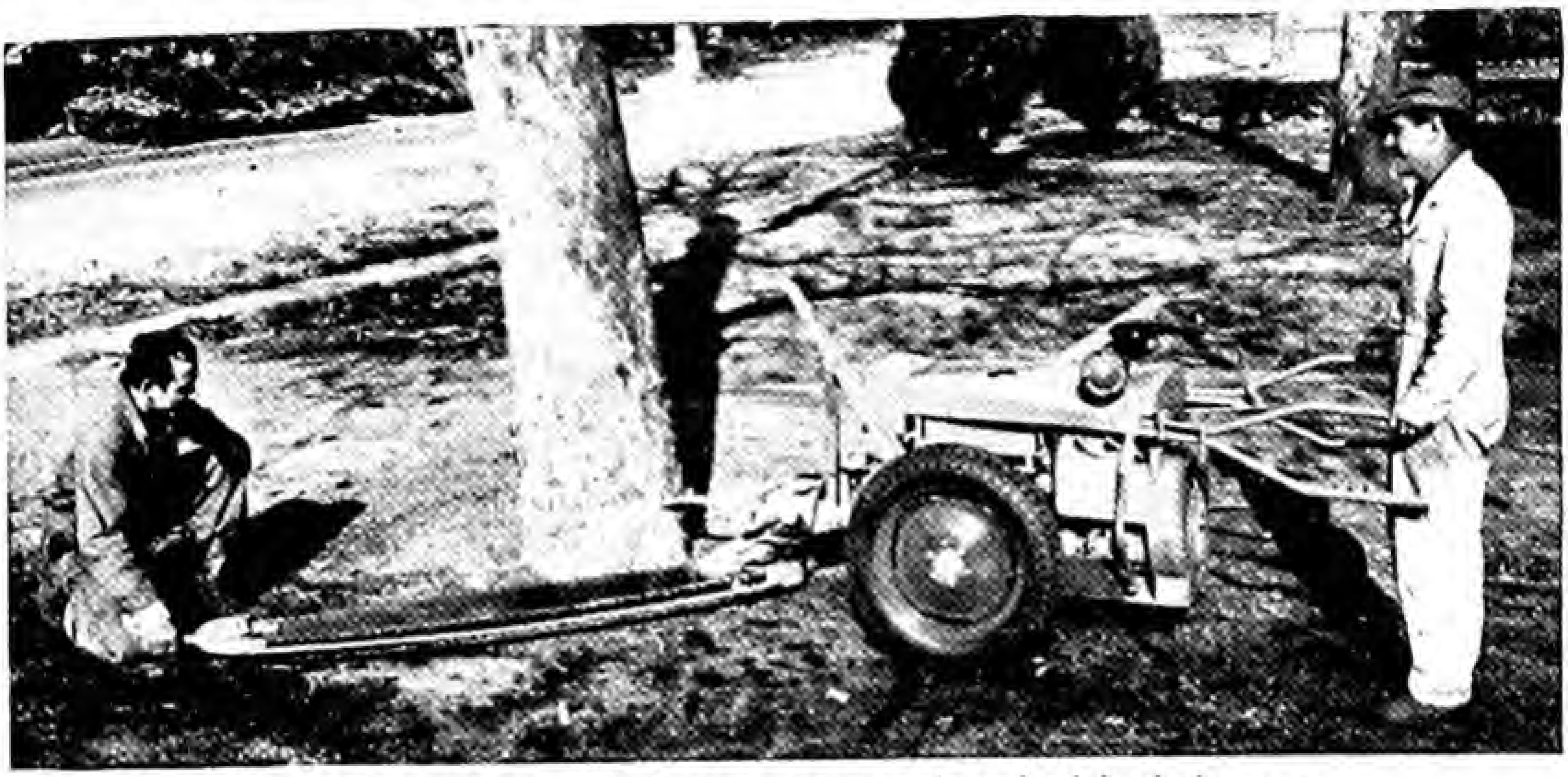


FIG. 777.—Self-propelled power saw equipped with chain saw.

blades. The twelve-bladed stalk cutter makes an excellent tool for cutting weeds, young sprouts, light brush, briars, and trash of all kinds. While cutting the undesirable plant growth it also cuts into the sod and performs a light cultivation.

Cutter blades have been fastened to large drums filled with water to add weight so that heavy brush can be rolled down and cut.

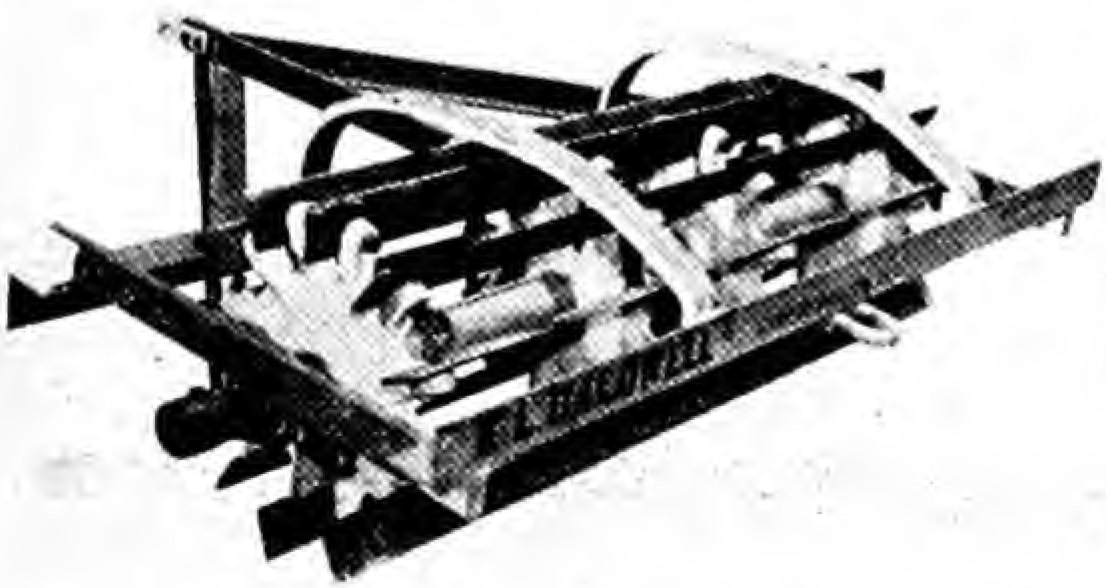


FIG. 778.—Stalk cutter designed for cutting of weeds and light brush.

598. Dragging Down Trees with a Cable.—Ranchmen of west Texas often use a steel cable pulled between two crawler-type tractors to pull down trees. The strip of land between the two tractors, which move parallel to each other, is from 30 to 60 feet in width. As the cable is

drawn forward by the tractors, it catches the tree close to the ground, pulls it over and uproots it. Small limbed bushes are not affected.

599. Tree Dozers.—A few large, specially built tree dozers have been used to uproot trees (Fig. 779). These machines are expensive and require a powerful crawler-type tractor.

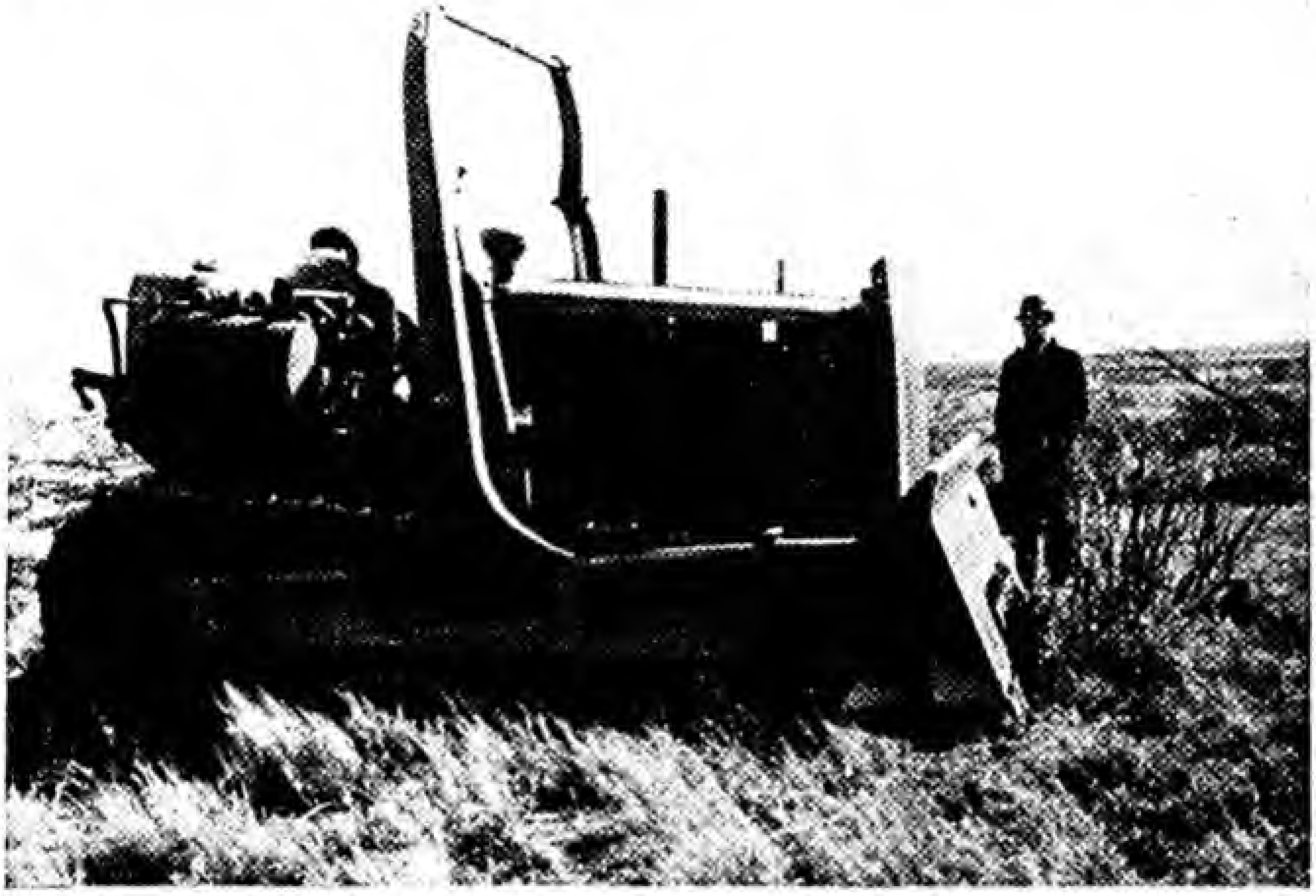


FIG. 779.—Tree and sprout dozer.

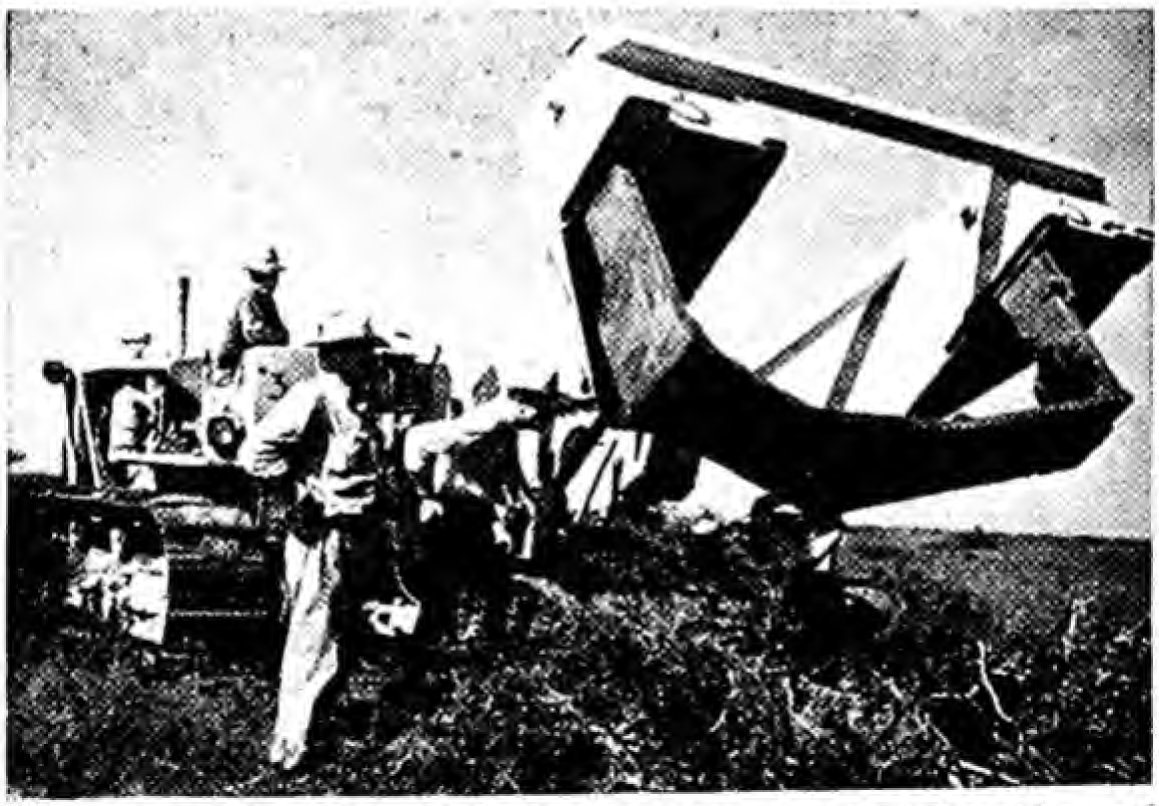


FIG. 780.—Giant rooter with U-shaped blade for cutting roots below the surface. The unit is lifted by hydraulic power from the tractor.

600. Root Cutters.—Figure 780 shows a large U-shaped blade which runs a few inches below the surface and cuts the roots of brush so that it will die. It leaves the top soil in place.

APPLICATION OF FERTILIZERS AND LIME

601. Applying Fertilizer to Pastures.—Fertilizer is usually applied on the sod, as there are no machines available to place it below the surface.

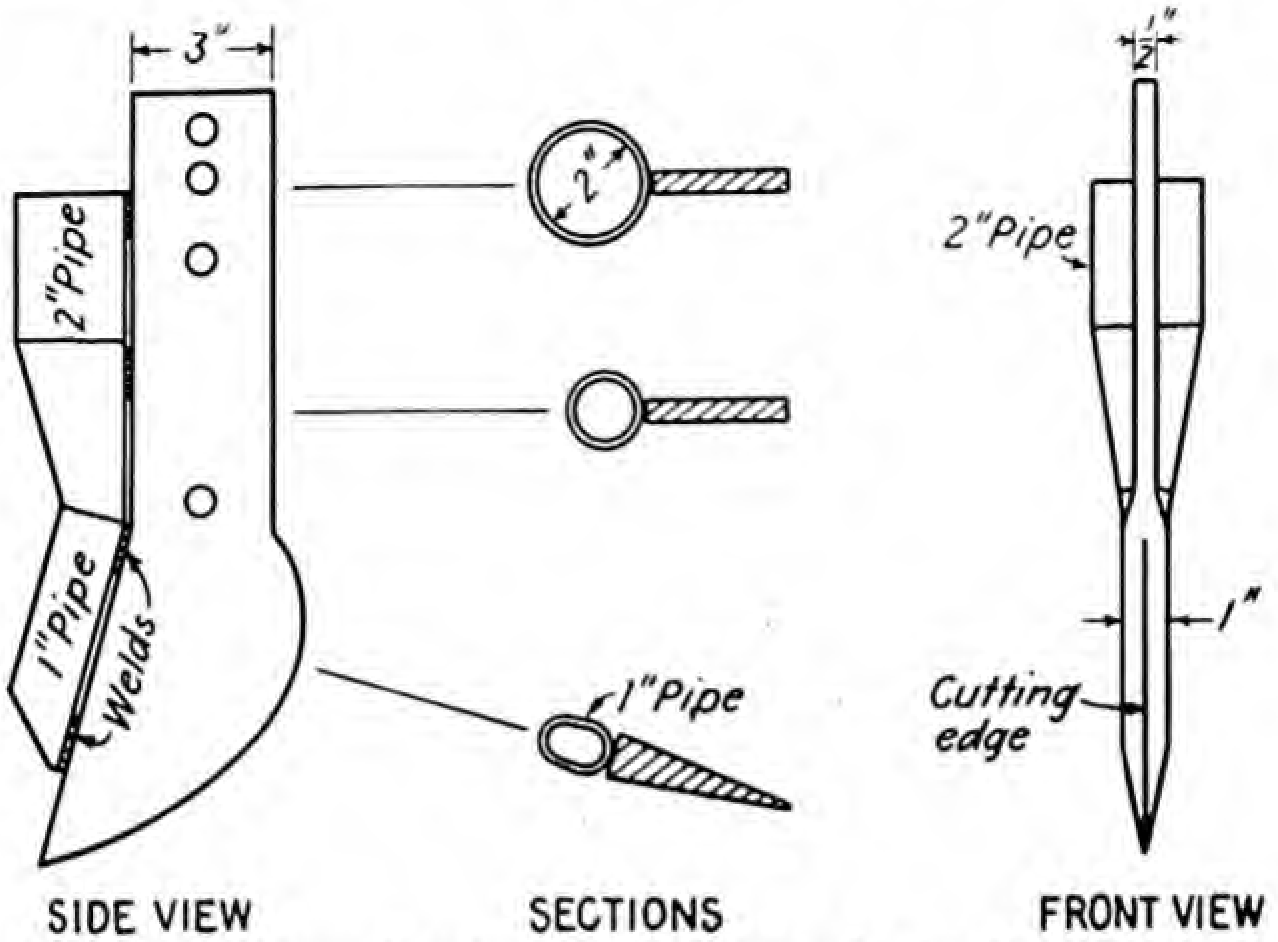


FIG. 781.—Knife to cut through sod and make furrow for fertilizer flowing through pipe behind the knife. (*Courtesy of M. R. Bentley.*)

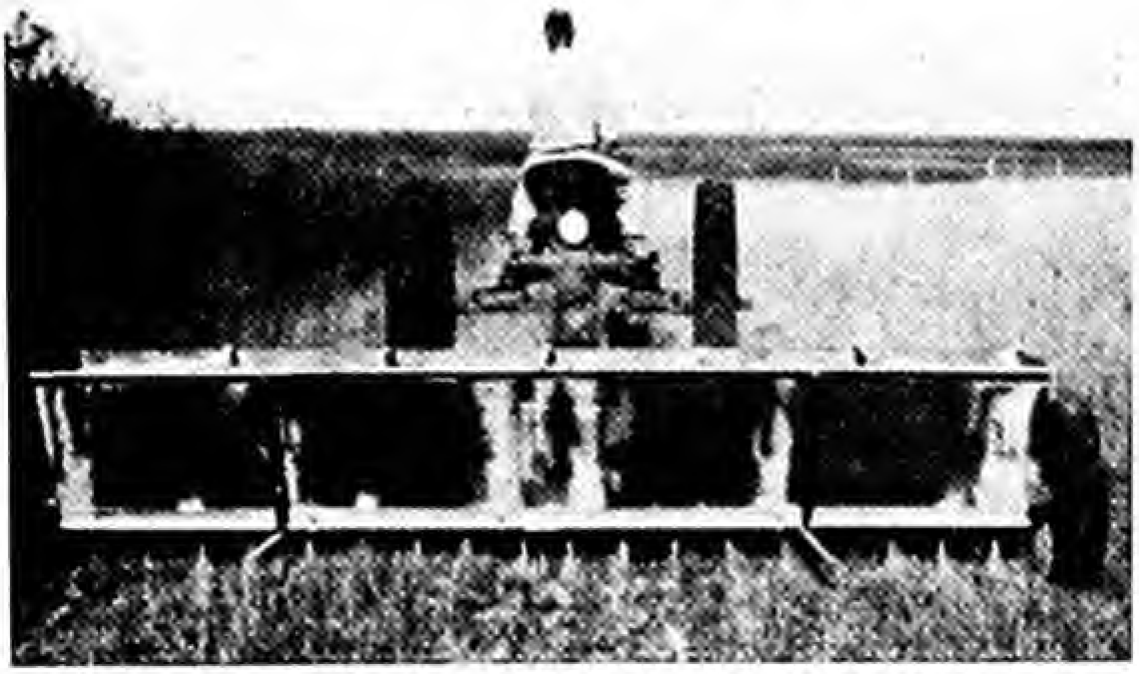


FIG. 782.—Homemade fertilizer distributor broadcasting fertilizer on pasture sod. (*Courtesy of M. R. Bentley.*)

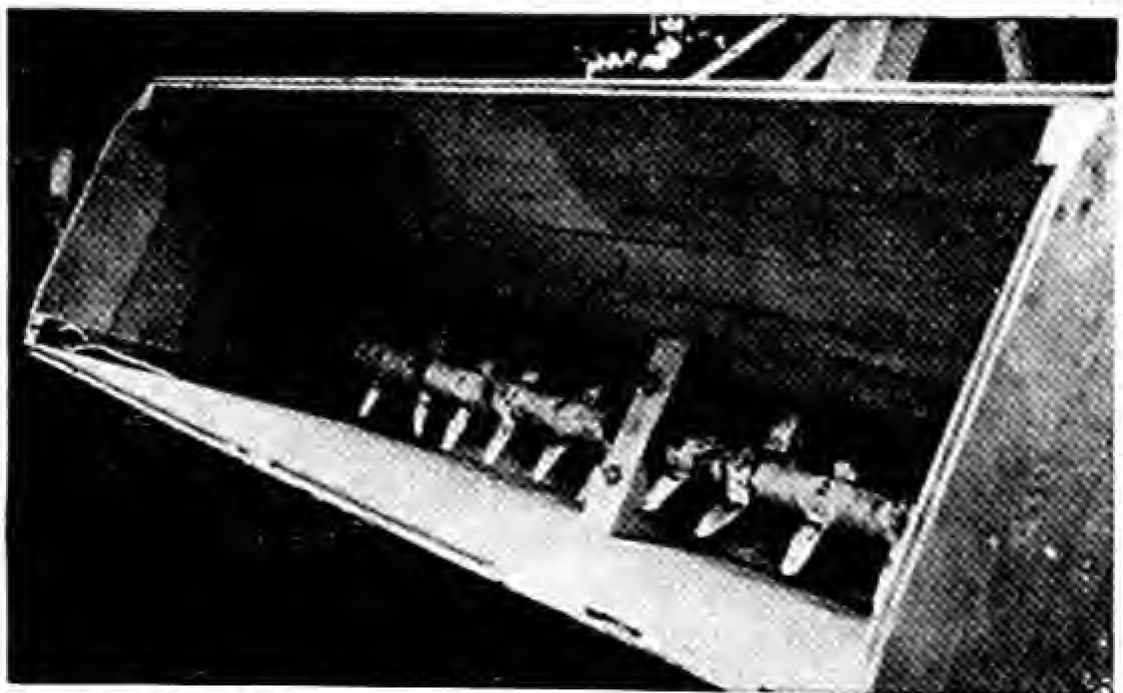


FIG. 783.—Overhead view of homemade fertilizer hopper showing agitators. (*Courtesy of M. R. Bentley.*)

The fertilizer is spread with broadcast end-gate seeders and regular two-wheel broadcast fertilizer distributors. Many homemade machines have been used to spread fertilizer and lime. Figure 781 shows a homemade knife to cut through the sod and make a furrow for fertilizer applied through a pipe attached behind the knife. Several of these knives can be attached to a tool bar. The fertilizer box is attached above the tool bar. The fertilizer is fed out of the box into flexible tubes attached to the top of the pipe boot, which extends below the surface.

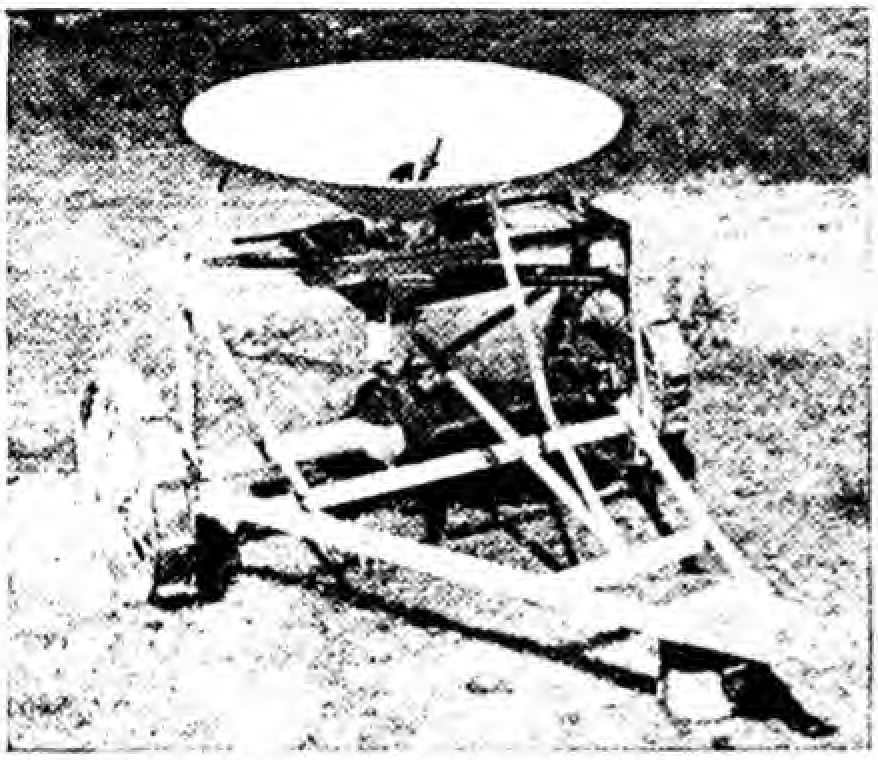


Fig. 784.—Homemade broadcast phosphate spreader.

Figure 782 shows a rear view of a homemade pasture fertilizer distributor. A sliding plate opens and closes holes in the bottom and regulates the quantity to be distributed. Figure 783 shows agitators inside a homemade box. Figure 784 shows a homemade broadcast phosphate spreader.

602. Applying Lime to Pastures.—Figure 785 shows a ground-driven lime spreader that can be drawn behind a truck or wagon. Two large rotating distributor wheels under the hopper spread the lime or fertilizer. The lime is shoveled by hand from the truck bed to the hopper of the broadcaster.

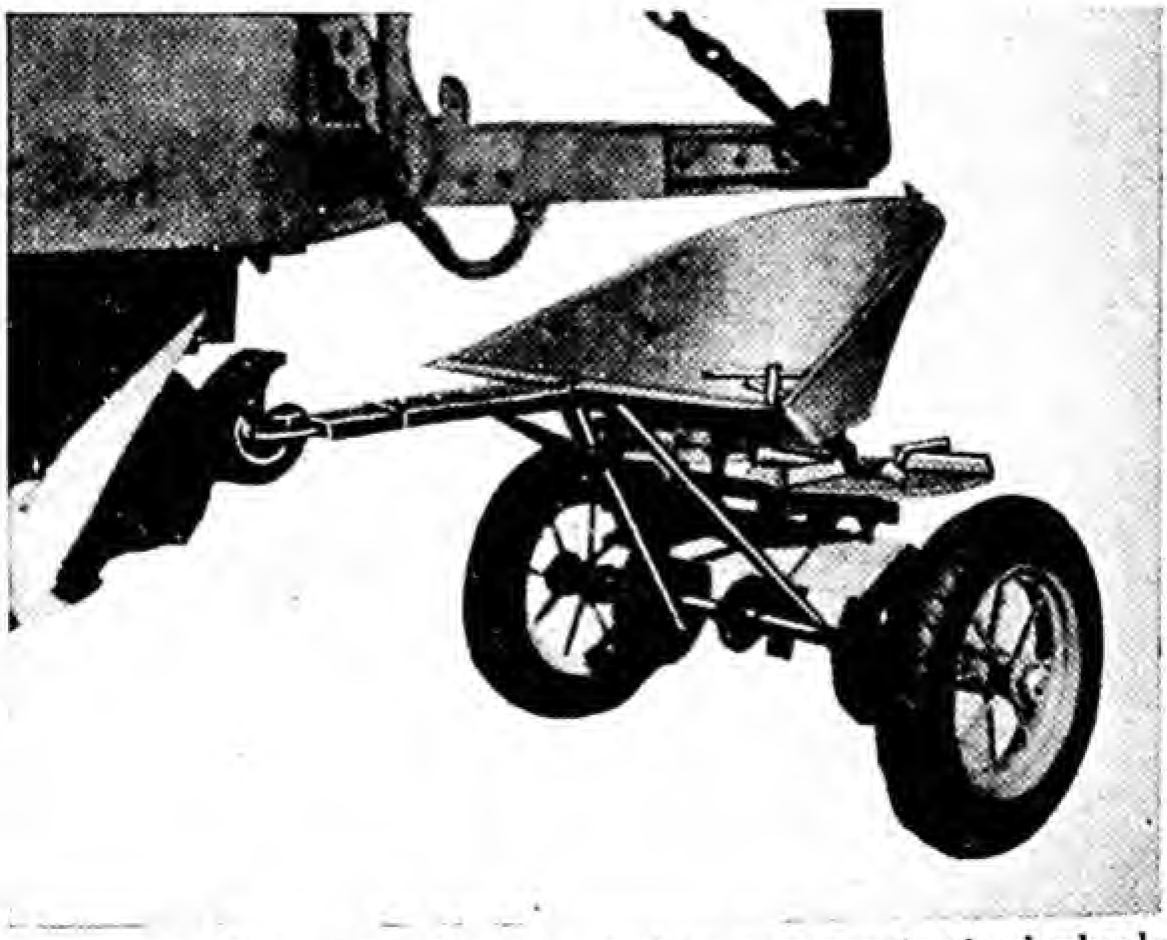


Fig. 785.—End-gate-type lime spreader mounted on pneumatic-tired wheels to trail behind truck or wagon.

PART XVII

ECONOMICS OF FARM MACHINERY

CHAPTER XXXVI

MAKING THE MOST OF MACHINERY

According to estimates made by the Bureau of Agricultural Statistics of the United States Department of Agriculture, there are now more than 2 million tractors of all kinds and sizes on American farms. This also means a large increase in equipment used with the tractor, both mounted integral equipment and tractor-operated equipment.

During the war years production of farm machinery was greatly restricted; however, production of some large machines such as cotton pickers, corn pickers, self-propelled combines, and windrow pickup self-tying hay balers has increased more rapidly than small units.

The development and adaptation of these and other high-capacity machines mean a reduction in man-hours and physical exertion required to produce a crop. Labor and power account for 60 to 80 per cent of farm operation cost. The chief function of a machine is to apply labor and power effectively and to accomplish the desired results with a minimum of human effort. In other words, the primary purpose of all the machinery of the farm is to reduce the cost of crop production. Therefore, in deciding whether or not it will be economical to purchase a new piece of equipment, it is necessary to decide whether by the use of this particular piece of equipment on any particular farm the cost of producing the crop will be reduced sufficiently that the machine will pay for its use.

603. Seasonal Needs.—When figuring on the best use of equipment seasonal needs must be considered. On the average farm it is rare for a piece of equipment to be used to full seasonal capacity because of the limited acreage that is grown to one crop. For example, with the exception of power, a 90-acre farm requires about the same number of units of machinery as does a farm of 180 acres. The larger acreage has greater seasonal use of machinery and the result is a lower cost per hour, per day, or per unit (pound, bale) for its use. It is not considered the best economy to pick 30 acres of cotton with a high-priced cotton picker which may have the capacity to pick 100 acres of cotton during a season, making allowances, of course, for the need for some reserve capacity to

offset late seasons, bad weather, and other delays. The operational cost of the cotton picker when spread over a small number of acres is relatively high, but if considerable custom work is done this cost can be largely offset by the returns.

Fenton and Barger[1] found the largest single factor affecting the machinery cost of doing a unit of farm work is the number of days the machine is used per year. Their studies revealed that the days of use per year varied from 7 days for the grain binder to 104 days for the truck, most of the farm implements being used less than 20 days per year. The combine may be used only 11 days, sit idle 354 days of the year, and yet be the most important machine in the economical production of wheat.

604. Machine Capacity.—A convenient method of calculating machine capacity for a 10-hour day is given by McKibben of Ohio, that is, the 10-hour-day capacity in acres of a field machine is very nearly equal to its width in feet multiplied by the speed in miles per hour. A 17.5 per cent time loss for turning, etc., is assumed in the calculation.

The average farmer should be interested in the following summary statements of Fenton and Barger of Kansas in regard to their studies on the cost of using farm machinery:

1. The total cost of operating farm machines is made up of the cost of machinery, power, and labor. Machinery costs include depreciation, interest on investment, taxes, insurance, shelter, repairs, and lubrication.

2. The most important factors affecting machinery costs are (*a*) use, (*b*) service life, and (*c*) investment.

3. The average number of days use of farm machines surveyed, exclusive of tractors, trucks, wagons, engines, and feed grinders, was 12.5 days per year. The five machines named were used a greater number of days per year because their use is not limited to one crop, one operation, or one season as is the case with most farm machinery.

4. The use of many machines was not affected by the size of farm measured in cultivated acres. The average use of combines and mowers did not increase with increased farm size. Tractors were used more days per year on the larger farms.

5. The average estimated service life of combines and mowers was not affected by farm size while the average service life of tractors was less on the larger farms.

6. The average service life for all farm machines was estimated to be 19 years. The range in estimated service life varied from 9 years for the small power-take-off combine to 34 years for the walking plow.

7. The estimated value of machines at the end of their useful life was 10 per cent of their original cost. For most machines this is a trade-in value and should be recognized in depreciation calculations.

[1] *Kans. Eng. Expt. Sta. Bull.* 45.

The wise farmer applies business principles to his farming operations. He should have the ability to judge the amount and the kind of equipment necessary to carry on most efficiently and economically the work on the farm which he is operating. Just so long as the American farmer can offset the increased cost of labor and the increased cost of higher living standards by increased efficiency through highly developed machinery, just so long will he be able to withstand competition in world production.

605. Percentage of Crops Harvested by Machinery and Other Methods.—The amount of some crops that is harvested by machinery is high, while for others it is quite low. Using the best information available in 1946, an effort has been made to estimate the percentage of the acreage of several crops as to method of harvesting.

	Per Cent
Corn:	
Harvested by pickers	35
Harvested by hand from stalk	40
Harvested by other methods	25
Harvested by picker in the different regions of the United States:	
Corn Belt	60
Great Plains	48
Appalachian	32
Other areas—less than 10	
Cotton:	
Hand-picked	90
Hand-snapped	9
Machine-picked	0.5
Machine-stripped	0.5
Small grains:	
Combined	90
Other methods	10
Rice:	
Combined	65
Other methods	35
Soybeans:	
Combined	90
Other methods	10
Beets:	
Mechanical diggers	35
Other methods	65

	Per Cent
Potatoes (Irish):	
Mechanical diggers	80
Other methods	20
Potatoes (sweet):	
Mechanical diggers	15
Other methods	85
Sugar cane:	
Mechanical harvester	70
Other methods	30

606. Labor Requirements.—In using any farm machine, no matter whether it is a plow or a combine, the owner should be interested in its approximate daily performance and the amount of labor required for its operation. Table XXII, prepared by the U. S. Department of Agriculture, Bureau of Agricultural Economics, not only gives the amount of work performed and the man labor required per acre but also the number and size of the various types of machines.

TABLE XXII.—NUMBER AND SIZE OF MACHINES ON FARMS, RANGE AND AVERAGE AMOUNT OF WORK PERFORMED OR ACREAGE COVERED PER 10-HOUR DAY, AND MAN LABOR NEEDED PER ACRE FOR SPECIFIED FARM MACHINES (From BAE Bulletin F.M. 42 by A. P. Brodell and James W. Birkhead)

Kind and type of machine	Number of machines on farms, Jan. 1, 1942, thousands	Size of machine on farms, Jan. 1, 1942		Amount of work performed with machine in 10 hours in 1941		Man labor per acre, hours
		Usual range, feet	Average, feet	Range, acres	Average, acres	
Moldboard plows:						
Tractor	1,461.2	1 – 7	[1]	3 –25	8.0	1.25
Horse, riding	1,041.0	1.2– 3.5	[2]	1.5–10	2.9	3.45
Horse, walking, 2-horse and larger	4,019.0	1.0– 1.5	[2]	1 – 3	1.7	5.88
Horse, walking, 1-horse	2,549.5	0.5– 0.8	[2]	0.6– 1.2	0.9	11.11
Disk plows:						
Tractor	166.4	1 –10	[1]	3 –35	9.8	1.02
Horse	83.7	1 – 7	[2]	1.5–15	3.9	2.56
One-way disk plows[3]	159.8	4 –16	[2]	6 –50	23.2	0.43
Disk harrows:						
Tractor	1,181.4	4 –21	[2]	7 –70	21.7	0.46
Horse	1,332.8	3 –10	[2]	3 –25	8.1	1.23
		Rows	Rows			
Listers and busters:						
Tractor	288.3	1 – 4	[2]	8 –60	21.0	0.48
Horse, riding	232.6	1 – 2	[2]	5 –18	7.9	1.27
Horse, walking[4]	1,065.0	1	[2]	4 – 8	4.9	2.04
Row-crop planters:[5]						
Tractor	204.3	1 – 4	2.5	6 –50	20.8	0.49
2 horses and more	1,705.5	1 – 2	[6]	6 –25	11.5	0.87
1-horse	1,745.6	1	1.0	4 – 8	5.5	1.82
Row-crop cultivators:[7]						
Tractor	887.9	1 – 4	[2]	8 –45	19.3	0.52
Horse, riding	2,357.0	1 – 2	[2]	6 –20	7.3	1.37
Horse, walking, 2-horse	835.5	1	[2]	4 –10	5.7	1.75
Horse, walking, 1-horse	3,908.0	0.5– 1	[2]	2 –10	3.7	2.70
Row binders:						
Tractor	82.0	1 – 2	1.1	8 –20	8.4	1.19
Horse	527.7	1	1.0	4 – 8	6.0	1.59
Corn pickers	129.9	1 – 2	1.6	4 –20	9.6	[2]
		Feet	Feet			
Mowers:						
Tractor	313.6	4 – 8	6.6	5 –35	19.7	0.51
Horse	2,565.0	3.5– 7	5.2	4 –15	8.5	1.18
Dump rakes	2,165.5	6 –12	9.8	10 –40	18.0	0.56
Side-delivery rakes	713.8	6 –12	9.3	8 –35	17.4	0.57
Grain drills:						
Tractor	422.3	4 –16	10.4	8 –60	25.5	0.36
Horse	1,289.8	3 –12	7.2	4 –35	10.1	0.91
Grain binders:						
Tractor	366.1	6 –12	8.6	8 –40	18.2	[2]
Horse	1,018.6	5 –10	6.9	6 –25	10.8	0.90
Combines	264.3	3.3–28	8.8	5 –60	18.8	[2]
		Inches	Inches	Bushels	Bushels	
Grain threshers	167.8	18 –42	25.9	250 –2,500	829	[2]
Peanut pickers	8.4	[2]	[2]	200 – 800	400	[2]
Hay balers:				Tons	Tons	
Windrow pickup	25.0	[2]	[2]	10 –40	19.0	[2]
Stationary, power	60.6	[2]	[2]	8 –35	18.0	[2]
Stationary, horse	62.8	[2]	[2]	4 –10	6.0	[2]
		Bushels	Bushels			
Manure spreaders	1,158.1	30 –125	65.0	6 –35	12.5	[2]

[1] The average width of cut of all tractor plows in 1940 was 31.3 inches. (See BAE report F.M. 32, fuel consumed and work performed with farm tractors.) It is believed that the average tractor moldboard plow is smaller than the average tractor disk plow.

[2] Data not available.

[3] One-way disk plows are commonly known as *disk tillers* in some areas, especially in the South Atlantic and South Central states.

[4] Most of the walking listers and busters in the Southern states are one-horse middlebusters.

[5] Includes surface and lister corn planters, cotton planters, and combination corn and cotton planters It does not include beet drills, potato planters, garden planters, or other planters adapted largely for crops other than corn and cotton. However, crops other than corn and cotton are often planted with combination corn and cotton planters.

[6] About 96 per cent were two-row planters and 4 per cent were one-row planters.

[7] Does not include field cultivators such as rotary hoes, duckfoot cultivators, and rod weeders.

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